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THE
NORMAL AND PATHOLOGICAL
HISTOLOGY
OF THE
HUMAN EYE AND EYELIDS

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THE
NORMAL AND PATHOLOGICAL
HISTOLOGY
OF THE
HUMAN EYE AND EYELIDS

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WITH TWO HUNDRED AND THIRTY ORIGINAL DRAWINGS
By the Author
(LITHOGRAPHED IN BLACK AND COLOURS)

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TO THE MEMORY OF

My Master,

PROFESSOR v. JAEGER, OF VIENNA,

WHOSE TEACHING AND EXAMPLE

FIRST ENCOURAGED ME TO THIS UNDERTAKING.

PREFACE.

In this book an endeavour is made to furnish students of ophthalmology with a concise account of the normal and pathological histology of the human eye and eyelids. An intimate acquaintance with healthy structure and the changes resulting therein from morbid processes forms the basis of intelligent clinical work; and yet the space devoted to the consideration of these matters in text-books and manuals dealing with the medical and surgical aspects of the diseases of the eye is necessarily limited. Practical instruction in the subject is not generally available; and the literature regarding it, which is chiefly foreign, is beyond the reach of many. The aim throughout the following pages has been to present the information derived from microscopical examination of the eye in health and disease, not only as a matter of scientific value, but also as of importance in its direct bearing upon a special branch of surgery. Conditions not peculiar to this department, as, for example, some affections of the skin of the eyelids, and also rare intra-ocular and extra-ocular tumours, the characters of which correspond with those of similar growths occurring elsewhere, are only briefly referred to; and theoretical questions have been avoided, although, it may be confessed, the temptation to include them was strong, owing to their inherent interest.

All classifications are artificial, and so far unsatisfactory; at the best they are merely conveniences. The most suitable arrangement is founded on the different tissues of which the eyeball is composed, and accordingly these structures have been considered separately. Short clinical notes, however, are given, where thought desirable, along with the descriptions of the drawings of diseased conditions, in order that the relations of the chief pathological processes to one another may be understood.

The volume embodies the results of continuous research during several years; and the specimens from which the illustrations are drawn are such as any one with access to a sufficient amount of material can prepare for himself. The figures are careful representations of preparations selected as typical and instructive from a large collection; and their deficiencies have been left unaltered, without any supplementary touches from specimens more perfect in some details. They have all been drawn twice by myself with the help of a camera lucida, first with pencil and again with lithographic materials. The copies were then compared with each other, and any little discrepancies corrected by further reference to the originals. It is hoped that by this double labour greater accuracy has been secured. The mechanical part of transferring these drawings to stone has been satisfactorily executed by the lithographers, and the use of colours for printing has been resorted to in order to bring out the requisite effect. In one or two instances it seemed preferable to utilize specimens from the lower animals; and these are noted in the proper places.

As histological methods are now so familiar to the medical profession, it need only be mentioned that the usual reagents and appliances were employed. Most of the tissues were hardened in a solution of chromic acid, or in Müller's fluid, a few with the aid of picric acid. The sections were cut by means of a freezing microtome; logwood, carmine, picrocarmine, aniline dyes, nitrate of silver, and chloride of gold were used for staining; and the preparations were mounted in glycerine, dammar, or Canada balsam.

The order of the illustrations agrees as closely as possible with that of the text, and the figures will be most profitably examined and fully understood, when studied consecutively in connection with the corresponding section of the systematic portion of the book. This arrangement seemed more convenient for the reader than the use of constant references from the first to the second part of the work, each of which, however, depends upon the other for its complete comprehension.

It was found that a detailed notice of the bibliography would have added greatly to the size of the volume without commensurate advantage to those who are likely to use it. A glance at foreign monographs, dealing with parts of the subject, where such references are given, will show the magnitude of the undertaking. For statements which I have been unable to verify, however, adequate authority is quoted.

I have to thank a few friends for some material kindly put at my disposal; and to Dr. Arch. K. Chalmers, of Mossend, I am indebted for a careful revision of the proof-sheets.

C. F. P.

HILLHEAD, GLASGOW,
July 1886.

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HISTOLOGY
OF THE
EYE AND EYELIDS.

EYELIDS AND CONJUNCTIVA.

I. Normal Structure.

The eyelids are complex structures, many histological elements entering into their composition. Each lid is covered externally with skin, and on the surface next the eyeball with mucous membrane; and contains striated muscle, plain unstriped muscle, dense fibrous tissue, loose connective tissue, fat, hairs, glands, nerves, blood-vessels, and lymphatics. The relations of these to one another and their arrangement are best studied in sections taken at right angles to the free edge of the lid, although sections passing in other directions may be necessary to elucidate some points. The outline of such a vertical or sagittal section of the upper lid is long and narrow, the slightly curved surfaces running from the ciliary border more or less parallel with each other until about the orbital margin of the tarsus, where they begin to diverge, the conjunctival surface bending inwards towards its reflection at the cul-de-sac. The outer corner of the free border is rounded off; the inner is nearly rectangular. The outline of a vertical section of the lower lid, on the other hand, is shorter and thicker, and has rather the shape of a thick wedge, for the surfaces form an angle at the junction of the skin and conjunctiva.

The *skin* is delicate. Everything is in miniature. The epidermis and corium are thin; the papillæ are small; the hairs, which have frequently no apparent sebaceous gland attached to their follicles, are extremely fine; and the sweat glands, with the usual confused coil of convoluted tube in the subcutaneous tissue and a pretty straight duct leading to the surface, are minute, though often abundant. The surface is wavy and wrinkled. Both in the epidermis and in the cutis a very considerable quantity of brown particles of pigment occurs occasionally in clusters, and this pigmentation is sometimes specially noticeable in the deeper layers of the epithelial cells and in the adjacent corpuscles of the cutis in the neighbourhood of the cilia.

The *subcutaneous layer* is composed of loose connective tissue, with its bundles of white fibres mixed with some elastic ones and scattered corpuscles. In the tarsal region there is no fat, but towards the orbital portion there are collections of adipose tissue. The lymphatics are usually numerous and distinct in ordinary preparations.

The *eyelashes*, or *cilia*, are large well-developed hairs springing from the outer edge of the free border in from two to four rows. They are curved, the point bending away from the conjunctiva; but they do not swerve to either side. Small sebaceous glands are sometimes seen connected with their sheaths, and the acarus folliculorum is an occasional occupant of the opening, where the little parasite lies among the loose epithelial scales.

Underneath the subcutaneous tissue there is the *orbicularis palpebrarum* muscle. In a vertical section of the lid, the variously shaped fasciculi of the striated muscular fibres, bound together by connective tissue, are seen cut across, and form a comparatively thick band in the whole extent of the eyelid, terminating anteriorly at the roots of the eyelashes. Some bundles, separated from the others by the intervening cilia and the glands of Moll, constitute the *musculus ciliaris Riolani*, part of which is situated between the roots of the eyelashes and the ducts of the Meibomian glands, part between these ducts and the conjunctiva, while a few fibres lie behind this point between the most anterior alveoli of the glands and the conjunctiva.

The *tarsus* is a plate of dense white fibrous tissue, in which numerous elongated nuclei are easily demonstrated. The fibres run in manifold directions, and the density of the structure obscures its details. It is separated from the over-lying orbicularis by a layer of loose connective tissue, in which a few fat cells are occasionally found. Corresponding with the shape of the upper and under lids respectively, the tarsus of the former extends much further back from the edge than that of the latter. In both cases the palpebral margin is immediately under the epithelium, and ill-defined, while the orbital margin is thinner, and continuous with the surrounding tissue, in which there are well-marked bands of involuntary muscular fibres, with their elongated nuclei, passing from the tarsus and mostly parallel with the conjunctival surface, though the individual fibres run in various courses. In the upper lid white fibres, forming the tendon of the levator palpebræ superioris, are also attached to this portion of the tarsus. In both lids fat cells frequently are present close to the plain muscular fibres, and amongst the strands there are scattered large, spherical, very granular, nucleated corpuscles.

The *Meibomian glands* are embedded in the tarsus. The wide central duct of each opens on the free edge of the lid near the inner margin, and extends from this parallel with the conjunctiva to the distal alveoli. Among the alveoli it is badly defined, fragmentary, and sacculated; nearer the mouth it is narrower and tubular. It is lined with stratified epithelium, the superficial cells of which are flattened and have an oval nucleus, the deepest cells being somewhat columnar with a round nucleus. About the sides of this main duct are placed the roundish bulbous alveoli, which are comparatively large cavities, and may be sub-divided, their mouths either opening directly into the duct, or being connected with it by a short constricted neck. They appear as isolated spaces, if the section has passed along by the side of the duct; but in fortunate specimens, including the latter, the whole arrangement of the gland is well displayed, and is exceedingly beautiful. The alveoli are lined by a single layer of short columnar or cubical cells with round nuclei, continuous with the deepest epithelial cells of the duct, and they are often occupied by an opaque mass, consisting of scales and irregular nucleated bodies filled with fatty particles, glued together with granular débris. Similar material is found in the duct itself. One of the distal alveoli is sometimes slightly distended, and then forms a round open space. Successive sections parallel with the edge of the lid enable the following facts to be noted. Near their mouths the ducts form a series of circular openings in the epithelium, nearly but not quite equally distant from the conjunctival surface; further back they are rings of stratified epithelium among the connective tissue; a little further back the outer surface of the outline of these rings is irregular, and then immediately behind this the first appearance of the alveoli is seen. The glands and ducts are in this part of their course separated from the roots of the cilia and the glands of Moll by the longitudinally cut bundles of the musculus ciliaris Riolani, from which some fibres pass obliquely between them towards the conjunctival surface to mingle with the few inner strands of the muscle running parallel with the main outer portion. The ducts or glands are thus in a manner embraced by the muscle. Behind this the ducts are much larger, and are surrounded by the alveoli on all sides, amongst which some of the oblique connecting muscular fibres can be observed. Owing to the direction in which many of the alveoli open into the duct, it is not always possible to trace the connection between the two, most of them being isolated irregular spaces clustering round, but entirely free from, it. Where this arrangement prevails, the duct has well-defined walls, but in sections, where some of the acini happen to open into it, it seems very irregular and without definite boundaries. Each gland here forms a separate group of alveoli about the wide duct, rather uneven in outline and separated from its neighbours by a thin partition of the dense tarsus. A little further back the inner muscular fibres are wanting, and the groups are somewhat square in outline with rounded corners. They retain this character throughout the rest of their extent beneath the orbicularis, but are still larger, and, as the posterior border of the tarsus is approached, some of them cease, and their place is then taken here and there by the racemose or tubular glands to be mentioned next.

Racemose and tubular glands occur in the region of the fornix in the loose sub-epithelial tissue, and similar structures are found in the adjacent part of the tarsus, a considerable extent of the orbital or posterior portion of which may be so occupied. The majority of sagittal sections, however, do not show these, and the Meibomian glands then extend well up to the margin of the tarsus.

The *glands of Moll* are situated at the palpebral edge of the lid, and, when present in a vertical section, are seen near the roots of the eyelashes, close to the musculus ciliaris Riolani. They are formed apparently of a long, wide, bending tube; and sections of them show a narrower portion running forwards beside the roots of the cilia, and, further back, irregularly disposed more or less round spaces of various sizes. Some of these are large, and resemble the neighbouring alveoli of the Meibomian glands. They are lined by cubical epithelial cells, and in the deeper part these may contain yellow or brown granules. Outside their basement membrane there are fibres and spindle cells with elongated nuclei; and, when these are seen through the curved wall in glycerine preparations, they give it a peculiar ribbed appearance, as if it were built up of many minute arches. The spaces are generally empty, but occasionally contain a mass of granular or nearly homogeneous material, which has sometimes a series of concentric lines. The glands open most commonly into the follicle of a cilium, but sometimes separately, though close to or associated with the follicle. Successive sections parallel with the edge of the lid show certain details. The deepest part of the longer glands is seen as a bending tube between the anterior portions of the neighbouring Meibomian glands; in front of this the section of each gland is larger, and lies outside the level of the Meibomian ones as an irregular saccule divided imperfectly into compartments by septa, as if a coiled wide tube had been cut across. Further forwards similar empty portions among the roots of the cilia form a prominent feature in this middle layer of the eyelid along with the dark roots of the hairs in the follicles, with a few insignificant sebaceous glands, and fibres of the musculus ciliaris Riolani. In advance of this the lumen of the gland or duct is narrower, and the cross sections of it and of one of the deeper hair follicles lie near each other; and then lastly it is seen as a small round opening in a thickened portion of the epithelium composing the follicle, or as a little tube passing through its wall.

In some specimens glands are seen in this locality, having the ordinary coiled knot of a sweat gland, beneath the orbicularis, but with a wider lumen than usual and a long duct, proceeding outwards in the same direction as the eyelashes.

The *conjunctiva palpebræ* is intimately united to the tarsus, and consists of two layers. Superficially there is stratified epithelium. Towards the edge of the lid the deep cells are cubical and those on the surface flattened; about the fornix or cul-de-sac the deep cells are still cubical, but the external ones are columnar, and many of them have the characters of goblet cells, with a deeper tapering extremity and an upper expanded portion filled with clear material; and in the furrows between the folds in this region the superficial cells are long, large, and uniform. The cells of the intermediate strata everywhere are irregular in outline. The sub-epithelial layer of connective tissue also presents different characters in different areas. Over the tarsus it is thin and comparatively dense; nearer the fornix it is loose. Besides its proper corpuscles, some of which now and then contain clusters of pale-brown granules of pigment, it contains many round lymphoid cells; and this adenoid tissue, which is sparingly distributed in the portion covering the tarsus, is very abundant about the fornix, and may here form minute undefined collections. True lymph follicles, such as described by Bruch in the eyelid of the ox, apparently occur in the human eyelid only in pathological conditions. Over the tarsus the surface of the conjunctiva is smooth, and no papillæ are found, the boundary line between the epithelium and the underlying tissue being quite straight or at most slightly undulating. Nearer the fornix there are irregular folds and ridges with intervening grooves and furrows; and, when these are seen cut vertically, they have somewhat the appearance of well-developed papillæ. At the cul-de-sac, sections of these irregularities not unfrequently resemble the arrangement of simple glands, a duct being formed by the close approach of the summits of two adjacent ridges, and an apparent alveolus by the greater separation of the deeper parts. A still closer similarity to the structure of glands is presented in places, where roundish spaces of some size, lined with epithelium, are embedded in the loose tissue and isolated; they are occupied by several layers of epithelial cells, and are seemingly merely portions of depressions on the conjunctival surface cut transversely.

The *conjunctiva bulbi* covers the anterior part of the sclerotic, and has an epithelial and a connective tissue layer. The superficial cells of the epithelium are flattened, the intermediate polygonal, and the deepest somewhat columnar. Some goblet cells, swollen and distended with clear material, may be present about the fornix; and near the cornea the epithelial layer is thicker, and in the eye of the negro particles of pigment tinge the cells, especially the deeper ones. The sub-epithelial layer is a network of white and elastic fibres, amongst which are seen the nuclei of corpuscles; and, as large numbers of lymphoid cells are present, the structure resembles adenoid tissue in many parts. The blood-vessels and lymphatics are numerous, and there are sometimes a few fat cells. The episcleral portion immediately outside the sclerotic, with which it is continuous, is rather more dense than the parts elsewhere, and just under the epithelium a similar but very thin layer occurs. There are no papillæ. The conjunctiva overlaps the margin of the cornea for a short distance, and this area receives the name of *limbus conjunctivæ.* The *plica semilunaris* is a fold of conjunctiva; and is surmounted by the *caruncula lachrymalis,* which is apparently modified skin, with fine hairs, sebaceous glands, fat cells, and some involuntary muscular fibres (Müller). I have sought in vain in the human conjunctiva for the bodies described as the end-bulbs of Krause.

II. PATHOLOGICAL CONDITIONS.

Œdema of the Eyelids.—The loose subcutaneous tissue of the lid is distended with serous fluid, and sections of such a case show large irregular spaces among bands of fibres in this region. Most of these are empty; but some contain a coagulum of finely granular material.

Blepharitis.—In inflammation of the edge of the lid there is a local infiltration, with inflammatory round cells, of the corium and subcutaneous tissue; and in sections from a severe case the outline is rounded off or otherwise altered. The follicles of the eyelashes may be involved, and pus cells occur about the roots of the hairs. The crusts are composed of epidermic and pus cells, glued together by an amorphous substance (Colberg).

Hordeolum or Stye.—This is characterized by a circumscribed collection of round cells, with necrosed tissue and products of degeneration in the centre, about the ciliary edge of the lid.

Chalazion or Meibomian Cyst.—In sections of an excised chalazion there is evidence of chronic inflammation or hypertrophy of some part of a Meibomian gland, with accumulation of its secretion in the enlarged alveoli. An external capsule of firm fibrous tissue sends inwards septa or trabeculæ, which divide the enclosed cavity into imperfect compartments. On the inner surface of these partitions there is a zone of epithelium, many cells of which are somewhat cylindrical. The succeeding layers of epithelial cells show partial fatty degeneration by the granular condition of the elements, and are more oval or spherical, those furthest from the septa lying rather loosely in a granular matrix. This zone stains deep yellow with picrocarmine, and forms the transition to the fatty mass occupying the centre, in which there are epithelial scales without nuclei, large, dark, opaque, swollen, globular bodies, and much molecular débris. These central collections are very friable, and may contain a calcareous deposit or crystals of cholesterine. They stain red throughout with picrocarmine and deep blue with logwood. At certain places it may happen that the fatty mass is in immediate contact with the connective tissue framework, the distended alveolus being completely filled with the degenerated material.

These conditions correspond histologically with some of the sebaceous cysts found under the skin of the eyelid.

There seem to be several varieties of chalazia. Some, of slow growth, have the characters just described; others, where suppuration has occurred, have an inflammatory zone of infiltration surrounding them; and others are made up of granulation tissue, forming a nodule of round cells with cement substance, traversed by many thin-walled blood-vessels. Schweigger limits the name chalazion to this last form, arising from the tissue of the tarsus and replacing the normal structures in the locality; and the term atheromatous cyst would then be applied to those tumours in which there is simply an accumulation of degenerated epithelial products.

Molluscum Contagiosum.—In this affection of the skin the appearances are those of a simple sebaceous cyst. The enlarged alveolus is lined by epithelial cells, and contains a mass of granular and fatty detritus with altered epithelial cells.

Dermoid Cyst.—This is a subcutaneous formation. The capsule, formed of fibrous tissue, encloses a single cavity. Its internal surface is lined with stratified epithelium; and the wall, which is smooth, unless the contents have escaped during or after removal of the tumour, is furnished with hair-follicles, hairs, and, generally, sebaceous glands. The contents, which stain deeply with logwood, are for the most part of epithelial origin, consisting chiefly of transparent scales, similar to those found lying in the mouth of an ordinary hair-follicle, mixed with opaque fatty globules and granules, cement substance, and scattered portions of fine hairs. Crystals of cholesterine may be present. Surrounding the cyst there is loose connective tissue, with fat, muscle, and other normal elements.

Epithelioma of the Eyelid.—As elsewhere, this consists here of an excessive development of epithelium. From the greatly thickened superficial layers irregular outgrowths, which may be branched, penetrate into the sub-epithelial tissue, and these sometimes contain cell-nests with the characteristic concentric arrangement. The neighbouring tissue is generally very vascular and considerably infiltrated with round cells, and the epithelial processes may pass gradually into this, or have a more sharply demarcated boundary.

Rodent Ulcer of the Eyelid is a carcinoma of the skin, which has ulcerated. The origin of the epithelial growth has been variously referred to the sebaceous glands, the hair-follicles, and the sweat glands.

Sarcoma of the Eyelid occurs under the epithelium, and involves all the various tissues. The tumour may be round-celled, spindle-celled, or mixed, and is sometimes pigmented.

Xanthelasma Palpebrarum or Xanthoma.—Descriptions of the histological characters of this disease of the skin of the eyelids, with its raised, flat, yellow patches and occasional tubercles, differ considerably from one another. It affects the corium, and here there is a new growth of connective tissue, which is of greater extent in the tuberous than in the plane variety of the affection. Among the fibres there are cells containing oil, which may be in the form of granules or globules. Needle-shaped crystals are sometimes observed. Bärensprung found fatty particles and globules between the fibres of the cutis. Pigment occurs as brown or yellowish molecules, and some of this lies inside cells; but the normal presence of pigmented corpuscles in this region must be borne in mind in estimating any excess. Clusters of this pigment are rather numerous in the walls of the lymphatic vessels. Distended sebaceous glands may form cysts in the midst of the patch of xanthelasma; and serous cysts have been described by Hutchinson.

Phtheiriasis Palpebrarum.—In this affection the crab-louse, the pediculus which more frequently lodges on the pubis, is found on the eyelashes; and all the stages of development from the early ovum to the mature insect are usually present. The *nit* is formed of the egg firmly fastened to an eyelash near the eyelid by a mass of clear substance, which surrounds the hair as a tube for a short distance, and projects at one side like a ledge or bracket, the ovum being fixed to this projection and to the distal part of the tube. The ovum, with its hard transparent wall, is slightly pyriform, and the thinner end, directed towards the root of the hair, is partly embedded in the bracket. The other end, looking towards the tip of the hair, has a wide mouth covered with a rough dome-shaped lid, the operculum. In the early stage the nit contains a yellow mass with large granules; in the later stage the limbs of the insect can be made out with more or less distinctness; ultimately the capsule is abandoned by the young pediculus, and is then empty and without an operculum. If several nits occur on one eyelash, the youngest is next the root. The free *pediculi* are of all sizes, from the small recently hatched to the large fully developed specimen. The latter is broad and short, the abdomen and thorax being welded together, and the head with its five-jointed antennæ being inserted into a notch in front of the thorax. From four rounded marginal projections on each side of the abdomen there spring little wavy bristles, and some still shorter bristles occur on the limbs. The dorsal surface of the transparent body is furnished with pointed spines, and the tracheæ throughout the interior with the stigmata along the margins are conspicuous. There are three pairs of legs; the two hinder pairs possessing curved claws, which are comparatively large, with knob-like opposing processes. The animal grasps either a hair on one side of itself, or hairs on both sides; and generally remains clinging to them tenaciously, when the eyelashes are pulled out. It bites into the skin, and the head is found directed towards the root of the hair. The females are larger than the males, and, while the posterior extremity of the former is notched, that of the latter is rounded off.

The following affections, occurring on the eyelids, agree histologically with like conditions in other parts of the skin:—

Tumours:—

Papilloma or Wart, a local hypertrophy with enlarged papillæ covered with thickened epidermis.

Nævus, a network of blood-vessels.

Lipoma, adipose tissue.

Fibroma, fibrous tissue.

Gumma, with a central granular caseous mass, surrounded by a zone of round cells and, outside this, by newly formed connective tissue.

Inflammations:—

Erysipelas, Eczema, Herpes, Acne, Small-pox.

Ulcers:—

Syphilis, Lupus.

Chemosis.—In this œdematous condition of the conjunctiva, the connective tissue layer is expanded, forming a loose mesh-work with irregular spaces. Inflammatory exudation is generally noticeable to some extent.

Muco-purulent Conjunctivitis.—The hyperæmia of this inflammation of the conjunctiva is indicated in sections by the distension of the vessels with blood corpuscles, the margin of the little clot being, as in sections of similar vessels elsewhere, sometimes surrounded by a serous coagulum, forming a yellowish, nearly homogeneous zone, the outer edge of which is scalloped by lacunæ or vacuoles between it and the wall of the vessel. Serous exudation may have rendered the connective tissue loose in its arrangement. In both acute and chronic conjunctivitis the irregular elevations on the palpebral surface are often much enlarged, and sections of the prominences with the intervening grooves resemble compound papillæ infiltrated with round cells, for the epithelium over the ridges is thicker in various places, where secondary furrows existed, and the boundary line between this and the underlying tissue with its collections of leucocytes is very uneven. Small closely packed accumulations of round cells may be found in the midst of the more diffused infiltration. The discharge consists of clear fluid, in which, entangled among strings and shreds of mucus, there float epithelial cells, spherical granular corpuscles with a round nucleus, and some pus cells with their bipartite or tripartite nuclei, the addition of acetic acid rendering the mucus more apparent, while bringing into prominence the nuclei of the cells in the usual way. Many bacteria are present.

Purulent Conjunctivitis.—All the conditions described in the last paragraph are found in preparations from this disease; but the infiltration with round cells is more extensive and profuse, and the œdema is well marked. The epithelium may be loosened and mixed with round cells, or partly destroyed as if macerated; but in many sections it appears quite normal, although the underlying tissue is densely crammed with leucocytes. The conjunctiva bulbi is usually involved, and also the episcleral tissue. A drop of the discharge consists mainly of pus cells, with much granular débris floating about.

Membranous Conjunctivitis is characterized by the presence of a membrane, apparently composed of fibrinous exudation with leucocytes, on the surface of the conjunctiva, which itself contains large quantities of round cells (Hirschberg).

Granular Conjunctivitis or Trachoma.—The distinguishing feature of this form of inflammation is the existence of small spheres or granules, resembling grey miliary tubercles, of adenoid tissue in the conjunctiva palpebrarum. The lymphoid corpuscles of the conjunctiva are abnormally abundant, and collections of them constitute the globular accumulations, which are like true closed follicles. In these there is a mass of round cells, crowded together in the meshes of a delicate reticulum, and traversed here and there by thin-walled blood-vessels. Towards the periphery the cells are more closely packed, and less intercellular substance is visible, while the central cells may be more granular, and the reticulum more easily observed. The limits of each collection are clearly marked, and one of two conditions is present; there is either an enveloping pseudo-capsule, which shades off into the neighbouring fibres, and seems to be the normal tissue pushed aside and so condensed, or the sharp demarcation is owing to the sudden cessation of the adenoid tissue, no fibrous boundary to the nodule being apparent. The connective tissue in the neighbourhood is studded with round cells, and possesses in addition numerous fusiform and branched corpuscles. The inflammatory infiltration is particularly dense towards the surface of the conjunctiva, while in the deeper layers there are many blood-vessels. The superficial epithelium is for the most part uninterrupted, especially in chronic cases; but it is sometimes partially or entirely absent over the little nodules, and, if more than one of these occurs in the prominence which their presence causes, the epithelium dips slightly between them. The granules may be found to have undergone fatty degeneration and more or less absorption; or in their place a local formation of organized cicatricial tissue, with consequent contraction, may have led to extensive fibrous changes with atrophy of the surrounding structures and distortion of the outline of the lid.

Phlyctenular Conjunctivitis.—Clinical observation shows that, before ulceration, in this affection there is on the ocular conjunctiva a small, circumscribed, sub-epithelial exudation of fluid, in which there are either a few leucocytes, when it forms a vesicle, or many pus cells, when it is pustular.

Hypertrophy of the Conjunctiva is caused by chronic conjunctivitis. Succeeding the inflammatory infiltration, there is a formation of connective tissue, so that the sub-epithelial layer is greatly thickened. It contains abundant round cells diffused throughout it, with larger collections under the epithelium and about the numerous blood-vessels, and also minute isolated aggregations in the deeper portions. The irregularities of the surface are comparatively large; and sections of the ridges often resemble compound papillæ, owing to the inequalities in thickness of the enlarged epithelial layer, the outer border-line of which seems comparatively smooth, while the deeper one is very uneven. In many places the ridges cannot be distinguished from each other, and at some points the boundary between the epithelium and the underlying densely infiltrated tissue is entirely lost, the different kinds of cells mingling with one another.

Sub-conjunctival Hæmorrhage.—In ecchymosis of the conjunctiva the meshes of the connective tissue are filled, and even slightly distended, with blood-clot, in which the fine outlines of the red corpuscles form more or less perfect rings, amongst which are scattered the granular white corpuscles, which are brought prominently into view by staining.

Episcleritis.—This inflammation of the deepest layers of the conjunctival connective tissue, at the junction of the cornea and the sclerotic, occurs both as an independent disease and also as part of conjunctivitis accompanying scleritis, cyclitis, or iritis. It is characterized by local distension of the blood-vessels and inflammatory exudation. The leucocytes abound in the much swollen and loosened tissue.

Pinguecula.—This small prominence near the margin of the cornea is composed of dense connective tissue, containing few blood-vessels with remains of others, which have been obliterated, and is covered by a thickened layer of epithelium (Weller).

Pterygium.—This excrescence outside the sclerotic and spreading over the cornea is a circumscribed hypertrophy or growth of the sub-epithelial layer of the conjunctiva, with the usual appearances of that tissue. There are bundles of fibres and also blood-vessels, which are more numerous towards the surface than in the deeper parts, while areas with a homogeneous substance, in which lie many cells, occur, more especially about the margins (Schreiter).

Xerosis.—In this condition of the conjunctiva, the sub-epithelial tissue is more dense than usual, and the epithelium is thickened, its outer layers being horny and mixed with granular detritus (Wedl).

Amyloid Disease of the Conjunctiva.—In this degeneration with thickening there are bright clear corpuscles and trabeculæ with a glancing appearance, which stain dark brown with a solution of iodine (Leber).

Conjunctival and Sub-conjunctival Tumours of various kinds have been examined, their histological characters corresponding with those of similar tumours occurring elsewhere. It will be sufficient to mention these very briefly.

A Polypus is most frequently situated about the inner commissure of the eyelids, and is composed chiefly of round cells and delicate blood-vessels, held together by loose connective tissue, which forms a matrix, in which there are little openings and spaces either empty or containing some amorphous material. The tumour is sometimes more fibrous in its nature (Fano). The surface is covered with epithelium.

Lipoma.—A fatty tumour may involve the conunctiva, or lie underneath it, and appears to be most ommon in the region between the superior and external ecti muscles (Graefe).

Fibroma.—Horner has described a fibrous tumour, pringing from the upper part of the conjunctiva ulbi, and presenting a papillary surface with blood-essels in the sub-epithelial papillæ.

Osteoma.—Little nodules of bone, with all the normal onstruction of that tissue, have been seen under the onjunctiva of the upper lid. They were surrounded y a layer of dense fibrous tissue (Schweigger).

Angioma of the palpebral conjunctiva is congenital, nd similar vascular tumours have been seen on the cular portion also (Blessig).

Lymphangiectasis.—Alt has described a tumour of the onjunctiva bulbi, consisting of irregular canals and paces between trabeculæ of connective tissue, partially ined with endothelium and containing serum.

Dermoid Growths near the cornea resemble fragments f skin, with epidermis, hairs, sebaceous glands, apillæ, cutis (with dense fibrous bands and looser onnective tissue), blood-vessels, nerves, and subcuaneous fat (Ryba).

Papilloma.—Sczokalsky has described a tumour, rising from the limbus conjunctivæ, in which papillary rocesses, composed of spindle-shaped cells and conaining blood-vessels, were covered with a stratified pithelial layer. Alt examined a growth, in which here were epithelial papillæ, amongst and in the cells f which lay granules of pigment; at some places cell ests were present; and there were also fine hairs and lands on the surface.

Serous Cysts with thin walls are found but rarely on the conjunctiva of the bulb (Schön).

Cysticercus Cysts, as recorded by Sichel, occur under the ocular conjunctiva.

Epithelioma of any part of the conjunctiva has the usual histological features of such growths; and, when it arises from the limbus conjunctivæ, the neighbouring tissues may be ultimately involved. The cornea is thus affected and destroyed, and the tumour spreads to the iris and other structures in the interior of the eyeball, or the epithelial elements gain an entrance to the globe along the sheaths of the vessels passing through the sclerotic (Alt).

Carcinoma of the palpebral conjunctiva has been noted by Hirschberg.

Sarcoma.—Sarcomatous tumours of the conjunctiva are commonly pigmented and very vascular. They may start from minute pigmented spots. Their component cells are round, spindle-shaped, branched, or mixed, and lie among the fine fibres of the stroma. When their origin is in the limbus conjunctivæ, they may be found simply overlapping the cornea, or their elements may have invaded this tissue and the sclerotic.

CORNEA.

I. Normal Structure.

A vertical section of the cornea shows five successive strata—viz., the anterior epithelium, Bowman's membrane, the substantia propria, Descemet's membrane, and the posterior epithelium. The bulk of the section is formed of the transparent proper substance; the anterior epithelium is conspicuous and of greater opacity; and the remaining layers are comparatively thin.

The *anterior epithelium* is stratified; and has externally two or three layers of large flattened scales. Underneath these, in the middle zone, the cells are irregularly roundish or polygonal; and, on isolating them, it is seen that the lower ones have hollows on their under surface, from which fine marginal processes and delicate wing-like expansions extend between the succeeding cells. In the underlying deepest row the cells are cylindrical or columnar; and, when seen separately, present manifold shapes, sizes, and lengths. Their blunt rounded anterior end fits into one of the hollows immediately in front, and their flat somewhat expanded base rests upon Bowman's membrane, the thickening of this border sometimes giving it a brighter appearance. The form of their sides is modified by their close arrangement; and, as the deeper portion may be slender, the cells are occasionally club-shaped. All the cells have a nucleus; in the superficial ones this is discoid, in the intermediate it is spherical, and in the lowest it is oval. The intercellular cement-substance is demonstrated by staining with nitrate of silver, and here and there the amount may be considerable.

Bowman's membrane resembles the substantia propria, but is clearer, less fibrillated, and more homogeneous. It is not sharply demarcated from the next layers, to which fibres pass; but it is destitute of corpuscles. In some pathological conditions it is very distinct, suggesting an even greater normal differentiation, such as an approach to the character of the posterior elastic lamina.

The *substantia propria* is made up of delicate white fibres cemented together to form bundles, these again being cemented into thin sheets, the general arrangement of which is parallel with the surface. This proper substance of the cornea is, therefore, modified white fibrous tissue. When fresh, or in glycerine preparations, sections of it are exceedingly homogeneous and transparent; but, after macerating the cornea in various fluids, the component fibres can, by teasing, be demonstrated, running in all directions with the wavy course of such fibrillæ, the successive layers frequently crossing one another. Though the structure is characteristically laminated, the lamellæ are not entirely distinct from each other, but rather intimately connected by numerous bundles passing obliquely between them; and in the anterior portion, towards Bowman's membrane, such bundles traverse several layers. In this region also the tissue is more manifestly fibrillated, the lamellæ are less distinct, and the points of union are more abundant. A vertical section mounted in glycerine shows bright clear strata bound together by many uniting bands. It is a glassy mass with cracks. The spaces or lacunæ between the layers appear more or less fusiform or spindle-shaped in vertical sections, but, when viewed from the surface, they are large and branched. Each of them communicates with its neighbours by means of longer lateral and shorter vertical canals (Rollett). In a surface view of specimens stained with nitrate of silver, these spaces form irregular white openings, from which spread channels of communication, in the browned or darkened groundwork. This is the lymph-canalicular system of the cornea, consisting of lymphatic spaces and canals. In the spaces lie the corneal corpuscles, flattened cells with a large somewhat oval nucleus, their shape and arrangement apparently agreeing pretty much with those of the lymphatic system. In stained vertical sections these bodies are seen in profile with their prominent nuclei in the spaces; but their processes are not visible in ordinary preparations. They are thicker at some parts than at others, or at one end than at the other. A few wandering cells or leucocytes occur in the canals and lacunæ, and are readily distinguished by their round nucleus. Only a portion of the spaces, in which the corpuscles lie, appears to be occupied by them; and, according to Klein, the difference in size between the lacunæ and the corpuscles is owing to the intra-nuclear and intra-cellular networks of fibrils taking on the dye, while the hyaline ground-plate of the cell remains unstained and therefore invisible. In surface views it is often difficult to determine what is lacuna and what is corpuscle; and the centre of the space may contain a nucleated mass, of irregular outline and not corresponding in any way with the details of the cavity, while in other instances the whole opening may seem filled with such material.

Descemet's membrane or the *posterior elastic lamina* is thin, bright, and homogeneous; and in sections forms a sharply defined clear line. In some cases fine longitudinal striæ suggest a fibrillated structure. It is intimately united with the adjacent substantia propria. Hassall first described the minute prominences or warty hyaline excrescences found occasionally on the posterior surface at the periphery, especially in the eyes of the aged.

The *posterior epithelium* is a single layer of polygonal cells with round or slightly oval nuclei. At the angles between some of the cells, openings or pseudo-stomata are sometimes seen in silvered preparations, but these may be artificial productions.

There are no *blood-vessels* in the cornea, except in the fœtus, when a network of capillaries occurs under the anterior epithelium (Müller). A ring of vascular loops surrounds the membrane at the corneo-scleral junction.

There is an abundant supply of non-medullated *nerve fibres* in the laminated substantia propria, the larger nerves lying in the lymphatic canals and being covered by a layer of endothelium (v. Recklinghausen). Their distribution can be satisfactorily studied in specimens successfully stained with chloride of gold; but they are quite indistinguishable in ordinary sections. Many observers have described the arrangement of their branches and of the terminal axis cylinders and fibrillæ, the accounts being at variance in some points; but the following statements seem to be established. There is a posterior supply and an anterior supply. In the former they have a comparatively straight course with somewhat rectangular bends, and terminate in a deep network close to the membrane of Descemet, through which fibres pass to the posterior epithelium. In the superficial supply they form a stroma-plexus in the anterior part of the substantia propria, and perforating branches proceed from this obliquely through Bowman's membrane; these then form a sub-epithelial network, from which fibrils penetrate between the epithelial cells and form an intra-epithelial network (Hoyer, Kölliker, Cohnheim, Waldeyer, Klein).

II. Pathological Conditions.

Keratitis or Corneitis.—Inflammation of the cornea is indicated by the presence of abnormal numbers of round cells throughout the tissue. Much discussion has taken place regarding the source of these, the debated points being whether, and how far, they owe their origin to immigration of white blood corpuscles from the margin with subsequent proliferation of these, or to proliferation of the corneal corpuscles themselves, or to both sources.

The corneal corpuscles may, under the influence of irritation, be the seat of *cloudy swelling*, a condition due apparently to excess of nutrient material with defective assimilation on the part of the cells. They are enlarged, unduly granular, and appear somewhat opaque in the distended spaces. This renders the affected region cloudy, and no other changes were present in a case described by Virchow as parenchymatous keratitis. This condition, which has the characters of *œdema*, also occurs along with evidences of inflammation.

Histologically several forms of keratitis can be distinguished; but they fall into three, partly overlapping, groups. These are infiltration, suppuration, and ulceration.

Infiltration of the Cornea.—Round cells lie scattered singly, in twos and threes, in short rows, or in small collections, in the interlamellar canals and lacunæ at some part of the cornea, generally in the deeper portions. Their presence in the more superficial layers may be accompanied by thickening and unevenness of the anterior epithelium, with irregular arrangement and shape of the component cells. In specimens where the cornea has become vascular, by a new formation of vessels in continuity with those at the margin, sections of blood-vessels are found along with the round cells. At first these have exceedingly delicate walls; and clinical observation shows that they, and also the inflammatory infiltration, may entirely disappear. In a later stage of development, however, their walls are well marked and fibrous, and their lumen is lined by flattened endothelial cells with large oval nuclei. This is the condition presented in cases of longer standing, in which the interstitial infiltration has been followed by organization, producing corneal opacity. Infiltration is found at the margin of a spot where there is suppuration.

Pannus.—In the superficial vascularity of the cornea, which is known clinically as pannus, there is an infiltration of round cells beneath the anterior epithelium, forming a layer of variable thickness, in the midst of which are seen portions and sections of blood-vessels. Lapse of time often leads to replacement of this to a large extent by a fibro-cellular or fibrous tissue, in which there are well-developed vessels.

Suppuration of the Cornea is characterized by the abundance and degeneration of the round cells together with destruction of the corneal tissue. *Diffuse purulent keratitis* may lead to destruction of the whole membrane or the greater part of it. A circumscribed suppuration forms a *corneal abscess*, which is superficial or deep, and involves a small or a large area. Locally nothing can be made out but an opaque mass of pus cells replacing the normal structures, with some coagulated fibrine and granular débris of the corneal tissue; the centre may have undergone degeneration, and possess few formed elements or none at all. The surrounding portions of the cornea are infiltrated, and may be vascular; and, if the tissues in front have been destroyed, and the abscess burst externally, the histological characters present are those of an ulcer. An abscess which has healed leaves its mark, and in such sections its former position is occupied by cicatricial tissue. Alt has described an abscess which healed without complete absorption and left a cyst in the cicatrix.

Ulceration of the Cornea.—The appearances vary in the different stages of a corneal ulcer. In the earlier ones there is at some spot a portion of the anterior layers wanting, and the floor and edges of the gap are covered with molecular detritus resting upon a zone of more or less dense infiltration, while portions of blood-vessels may be found in the neighbourhood. At a later stage there is no deficiency, but in its place there is a formation of cicatricial tissue with cells, the interlacing fibres, though more or less parallel with the surface, having none of the regular distribution or striking transparency of the corneal lamellæ. Bowman's membrane is absent over the spot, but its edge may extend for a short distance into the cicatricial mass. There is a covering over the cicatrix of stratified epithelium, which has grown in from the edges, but the posterior boundary line is uneven, nor do the cells present so orderly an arrangement as those which they have replaced. The surface of the cornea sometimes deviates locally from the normal contour.

Keratocele.—If an ulcer involves almost the entire thickness of the cornea, and the membrane of Descemet bulges forwards through this opening, the condition called keratocele, or hernia of Descemet's membrane, is present.

Phlyctenular Keratitis.—In the early stage there is a minute sub-epithelial collection of round cells, which, according to Iwanoff, is situated at the end of a nerve. There may be local destruction of Bowman's membrane, or the infiltration may extend even slightly deeper. At a later stage the conditions of an ulcer are found.

Descemetitis.—In this form of inflammation, which is also called *keratitis punctata* and *aquo-capsulitis*, little groups of round cells are found on the posterior surface of the cornea with altered epithelial cells. Sections of other parts of the eye show serous iritis, irido-cyclitis, or irido-choroiditis. The posterior corneal epithelium may proliferate, and yield round cells; and, judging from the various conditions found side by side in fortunate preparations, the stages seem to be as follows:—First the nucleus divides and then the cell by a median constriction; this constriction elongates, so that a new pyriform cell is formed, attached by a thin pedicle to its place of origin; the pedicle breaks, and a new, nucleated, large, round cell is set free.

Hypopyon.—Pus is sometimes found in the anterior chamber in connection with inflammation of the cornea, especially in cases of ulcer and abscess; and also occurs there in iritis or cyclitis. The cells may apparently have several sources; they are said to pass along the corneal canals from an inflamed part and through the spaces of Fontana into the aqueous humour, or a corneal abscess may burst into the anterior chamber, or possibly, according to Stromeyer, they may come from Schlemm's canal. Another source is found in an inflamed iris or ciliary body, and the pus cells are then embedded in a comparatively large amount of fibrine. Proliferation of the posterior corneal epithelium may produce large, round, granular cells.

Opacity of the Cornea.—When this is slight, it is called *nebula;* when dense, it is known as *leucoma.* After various forms of inflammation, the affected portion of the cornea is left with areas of opacity of larger or smaller extent, and this is owing to the substitution for the normal structure of fibrous or cicatricial tissue of variable density and opacity. Originally rich in cells, it has ultimately only a meagre supply; and, while in some cases many blood-vessels are present, in others they are few in number, or there are none at all. The former situation of deep-seated vessels is sometimes indicated by denser bands and cords of fibres. A considerable, or even the entire, thickness of the cornea may be involved, or only a few lamellæ, near the anterior surface or further back, may show any alteration. At a spot where an abscess or an ulcer previously existed, healing always results in a local opacity; an infiltration of the margin of the cornea frequently leads to a similar change, which may extend between the adjacent lamellæ for a short distance; and a long-continued widespread inflammation sometimes leaves the whole cornea opaque. The depth and area affected may thus be very considerable and the change most manifest; or, on the other hand, the dimness may be limited and quite inconspicuous. The anterior epithelium is often markedly thickened and irregular in depth; and patches with fatty molecules, calcareous deposit, or masses of clear highly refractive material, are occasionally present among the fibrous tissue or in the epithelium. Pannose tissue of some standing occurs in some cases, and then Bowman's membrane may be much broken up or even indistinguishable.

Wound of the Cornea.—Sections of a recent penetrating wound of the cornea show an opening filled with inflammatory exudation, composed of round cells cemented together by fibrine. The quantity corresponds of course, with the width of the wound; little more than a film marks a narrow fissure; a considerable mass plugs a large gap. Wounds passing obliquely through the membrane have, it would appear, their sides more closely approximated, while vertical incisions seem more liable to gape. The edges are infiltrated with round cells; and the distance to which this condition extends varies very much. In instances where it is small, the margins of the wound are sharply defined, and this is commonly the case; but, when the infiltration is more widely spread, the clear corneal substance shades off gradually into the opaque exudation. A similar dissimilarity is observed in the ultimate cicatrices of wounds which have healed. A noticeable and very frequent feature, especially in wounds of some width, is a local thickening of the cornea round the opening, there being a gradual increase in thickness from the surrounding normal part to the margin of the interruption, and this arises from the spreading out or loosening of the lamellæ, whose arrangement in vertical sections is rather fan-like, while the divided edges of the individual laminæ are rounded off. Bowman's membrane may bend into the wound.

Where healing is in progress, the place of the exudation is partly taken up by newly formed, more or less vascular, spindle-celled and fibrous tissue, with an extension of the anterior epithelium spread over it, such an epithelial layer sometimes dipping into the wound and occupying a considerable extent of its thickness. Where healing is complete, the site of the injury is readily distinguished by the finely fibrous cicatrix, which at first is a very delicate tissue and has many cells, but afterwards becomes more dense and contains fewer cells. It is then permanent, and many years afterwards forms a conspicuously opaque line or area, with bundles of fibres running in all directions, mingled with patent or obliterated blood-vessels. The corneal layers at the edges of the cicatrix are sometimes curved backwards; and pigmentation may occur from a deposit of blood-colouring matter as dark particles about a wound with hæmorrhage.

Neither the membrane of Bowman nor that of Descemet is ever restored when wounded or perforated, and they are therefore absent at the cicatrix; but the latter of them is often detached for a short distance, and a portion of it lies confusedly rolled or folded up in the adjacent new tissue, or it is simply bent backwards or forwards, with a cleanly cut termination.

There is commonly some alteration of the normal thickness of the cornea at the cicatrized spot, which may either measure more from before backwards than the neighbouring uninjured parts, or be somewhat thinner than them. The reduction in thickness is in some cases very considerable indeed, a comparatively thin bridge of fibrous tissue spanning the distance between the divided margins; and occasionally a cicatrix about the periphery of the cornea is found distended outwards and rendered cystoid, forming a vesicle filled with fluid and communicating with the aqueous chamber by a channel in the situation of the original opening.

If the lens has been involved in the wound and its integrity impaired, some of the curled-up capsule is very often embedded in the ultimate cicatrix or in similar material immediately behind that part of the cornea.

In cases of corneal wound, which have been followed by suppuration, sections from an eye removed in the stage of acute inflammation exhibit all the details of purulent keratitis.

Perforation of Cornea and Prolapse of Iris.—The cornea may be perforated by ulceration or by a penetrating wound; and, more especially if this happens towards the margin, a common consequence is the prolapse of the neighbouring portion of the iris through the opening, with subsequent incarceration. In sections of such a case various traces of the tissue of the iris are inextricably mingled with the inflammatory exudation or with the resulting cicatrix. The most prominent of these are portions of the uveal pigment, as scattered pigmented cells, free particles, or clumps of various sizes. Blood-pigment, from hæmorrhage at the time of injury, is also found in the form of reddish-brown granules or clusters of different kinds. Little cystic spaces occasionally occur in some part of the cicatrix, with cellular, molecular, pigmented, or fibrinous contents; and examples of an unclosed opening through the cornea of some standing have been seen, constituting *fistula corneæ*.

Synechia Anterior.—This is technically the name of an adhesion of a portion of the iris to some part of the cornea or to a corneal cicatrix; but similar adhesion may also occur between the cornea and the lens, or, in the absence of the latter, between the cornea and the vitreous. It may arise, for example, after a penetrating wound of the cornea or as one of the results of perforation by an ulcer; or continued pressure from behind may drive the iris forward against the cornea, until prolonged contact is followed by adhesion. In some instances of traumatic or inflammatory origin, the portion of the iris lies flat against the opposing part of the cornea; in others it is fixed only at the cicatrix or even in the actual perforation, and in such circumstances the real point of firm union is at or near the opening in the cornea, and by means of some inflammatory exudation. In other circumstances the nature of the substance, which binds the membranes together, is exceedingly difficult to determine ; or, even when the adjacent surfaces are united over a considerable area, not a film of interposed material can be defined in sections. In the majority of cases Descemet's membrane is wanting at the place of union, and its margin is folded or bent. The iris may be to some extent atrophied or destroyed ; and its pigment occasionally spreads into the cornea, the particles passing into, and lodging in, the neighbouring corneal canals and corpuscles, so that the transparent tissue is so far obscured by the dark dots. Cystic cavities are now and then found between the cornea and the iris at some place, containing coagulated, rather granular, amorphous substance ; and the iris is then locally atrophied and thinned by stretching.

Where the capsule of the lens is adherent to the cornea, the union is effected by inflammatory material ; and adhesion between the cornea and the vitreous occurs only when the latter is at least locally replaced by the products of inflammation.

Staphyloma of the Cornea.—A staphylomatous bulging outwards of the cornea is either partial, as, for example, when it is limited to the site of a cicatrix, or it is "total," in which case an opaque cornea is largely and more or less completely involved. Great alterations are found in the cornea and the iris. At the margin the transparent corneal tissue ceases suddenly, or passes gradually into the neighbouring cicatricial tissue of the protrusion; and at this point the continuity of Descemet's membrane is interrupted, and the iris is adherent to the cornea. In the area of the staphyloma itself there is either atrophy and thinning of the tunic, or, as seems to be frequently the case, there is great thickening, or again at one part the thickness is much reduced, while at another it is considerably increased. The tissue replacing the substantia propria is opaque and fibrous, though often retaining an indication of the normal lamellæ to some extent; it contains blood-vessels and collections of round cells, with occasional clusters or scattered particles of pigment in the deeper layers. In front the anterior epithelium is unequally thickened and irregular, its posterior boundary line in sections being undulating and dentated from the presence of small extensions directed backwards. Bowman's membrane is absent; and along the posterior border, which is usually rough, uneven, and almost ragged at some places, no membrane of Descemet can be distinguished, except perhaps about the margin, where fragments may be discovered. The adherent portion of the iris is atrophied, or almost entirely destroyed, so that the only evidence of its former presence may be a fragmentary line of pigment; and, although these extreme changes are limited to the staphylomatous area, over which the adhesion has been close and intimate in the absence of Descemet's membrane, some degree of atrophy may also be seen in the non-adherent portion of the iris. The anterior chamber is necessarily encroached upon, and either locally or completely obliterated; and the lens is displaced forwards or detached.

Thickening of the Cornea.—Besides the thickening, which occurs as a collar round a wide wound, and that which is seen in cases of staphýloma corneæ, the measurement from before backwards of the cornea as a whole is now and then found enlarged. This may happen where the eyeball has undergone partial shrinking, and the cornea is no longer stretched over so large an expanse as formerly.

Atrophy and Thinning of the Cornea.—The entire cornea or some portion of it, in the affection known clinically as conical cornea and keratoconus, is bulged forwards and reduced in thickness; and a similar uniform but local thinning of the tissue by stretching occurs in some cases of corneal staphyloma. Besides these conditions, however, a form of atrophy in shrunken stumps of eyeballs produces great wasting of the cornea, which is reduced to very small dimensions, sections of it showing a wrinkled, contracted, and distorted mass, in which the lamellæ no longer have their regular arrangement, and the lacunæ are greatly altered in shape and size, appearing as diminutive or exaggerated openings of irregular outline with a confused distribution. A layer of loose connective tissue may be interposed between this and the external epithelium. In contracted stumps of eyeballs, after perforation of the cornea, the situation of the opening is occupied by fibrous tissue, sometimes bearing a resemblance to the substantia propria, behind a layer of looser connective tissue.

Arcus Senilis.—In this opaque condition of the corneal margin, most frequently accompanying old age, there is fatty degeneration of the corpuscles of the cornea, and some granules lie among the fibres (Canton).

Tumours of the Cornea.—The following tumours seem to have started rather from the limbus conjunctivæ than from the cornea, and they are perhaps properly described in connection with the former structure:—

Granuloma, composed of round cells (Pagenstecher and Genth); *dermoid growths* (Ryba); *epithelioma* (Seitz); *sarcoma*.

SCLEROTIC.

I. Normal Structure.

The sclerotic, the external tunic of the eyeball, is thinner towards the front than at the fundus, and is composed of a dense felt-work of white fibrous tissue, mingled with some fine elastic fibres. These elements, united together by cement-substance, are in bundles, which interlace in all directions, but maintain chiefly either a meridianal or an equatorial course, in badly defined layers, and the membrane is thus more or less laminated. Some bundles run circularly round the entrance of the optic nerve, where the sheaths of the nerve join the sclerotic; and another set of annular bundles forms a ring in the inner scleral layers close to the cornea. In vertical sections of the corneo-scleral junction these annular bundles are seen cut across, and constitute a very distinct portion immediately outside and behind the ligamentum pectinatum; the most perfectly circular course of the bundles is just behind the canal of Schlemm, and the fasciculi further backwards take a more and more oblique direction, until, opposite about the middle of the ciliary body, they can no longer be distinguished from the other layers. If the insertion of the tendon of any of the ocular muscles is present in a section, the fibres are seen to penetrate the outer surface for a short distance at an acute angle, and then mix insensibly with the surrounding tissue.

The appearance of sections mounted in glycerine corresponds with that of similar tissue elsewhere, as, for instance, in sections of a tendon, and varies greatly in different cases according to the action of the hardening agent employed, the direction in which the fibres happen to be cut, and the thickness of the portion examined. The bundles are sometimes plainly composed of fibrillæ, in other preparations they are quite homogeneous. When they are cut at right angles, the part has the characters of a transverse section of tendon, with a clear glassy mass, broken up by irregular openings and cracks between the bundles, and occasionally dotted by the ends of the fibrillæ; when they are cut obliquely, this granular look is at times more marked; and, when they are cut longitudinally, the course of the fibres may be quite distinct. The thinner the section the more homogeneous does it seem, and the less distinguishable are the component fibrillæ.

In sections stained with logwood and mounted in dammar numerous corpuscles are brought into view, similar in appearance to those of the cornea. Seen from the side in such preparations, they seem spindle-shaped, and the nucleus may be elongated, though it is oval or somewhat round, when seen from the surface. The cells occasionally lie in pairs, with the nuclei in the adjacent ends. They are said to resemble corneal corpuscles with short processes, and to occupy similar spaces. A few of them, which lie in the inner layers, may contain particles of pigment, and such pigmented branched corpuscles, when present at all, are found most frequently and abundantly about the entrance of the optic nerve, and also near the corneo-scleral junction. Some wandering cells or leucocytes occur here and there.

Silvered preparations of the sclerotic show a system of lymphatic spaces and canals with an epithelioid lining, recalling the familiar arrangement in the central tendon of the diaphragm of animals, and the blood-vessels are surrounded by a lymphatic sheath.

Most of the blood-vessels found in the sclerotic are those which are penetrating obliquely to the deeper structures, and which give off a few small branches in their passage. Large ciliary nerves and vessels often pass through together, and their connective-tissue sheath is prominent, while occasionally its branched corpuscles are conspicuous owing to the rich supply of pigment in them.

The outer surface is covered with looser *episcleral* connective tissue, continuous with the conjunctiva in front, and this again is covered by a layer of epithelioid cells, which lines the inner surface of the lymphatic space, surrounding the greater part of the eyeball, and lying inside the loose fibrous tissue known as the *capsule of Tenon.*

The inner surface is lined by some delicate connective tissue and elastic fibres with branched pigmented cells, the shade of pigment in which varies from a light to a very dark brown, the cells themselves being of all sorts of shapes and sizes, some of them large and others small with thinner though longer processes. This is the *lamina fusca*, and its internal surface is apparently covered with a layer of epithelioid cells, such as is readily demonstrated in the albino rabbit by staining with silver. It forms the outer wall of the perichoroidal lymphatic space, the opposite wall of which is a similar membrane immediately outside the choroid, the *lamina suprachoroidea.* The perichoroidal space communicates with that enclosed by Tenon's capsule by means of the lymphatic sheaths of the blood-vessels, as they pass through the sclerotic (Schwalbe), and is traversed by the ciliary vessels and nerves and some fibres.

II. Pathological Conditions.

Sclerotitis.—Inflammation of the sclerotic is almost always secondary to a similar condition in some neighbouring part, and the outer or inner layers are more particularly affected according to the locality from which the inflammation has spread. There may be either an inflammatory *infiltration,* when leucocytes occur in little collections among the somewhat loosened fibres and bundles, especially about the blood-vessels; or there may be a *purulent* inflammation, in which case the normal tissue is locally destroyed, and its place densely packed with round cells. The pus may find its way through the choroid and retina into the vitreous, or the starting-point may be in the choroid, and the suppuration extend outwards and inwards from that layer; and, if a specimen is examined from a case in which such a state of matters has ended in healing, the spot is occupied by cicatricial tissue, uniting the membranes.

Wound of the Sclerotic.—A wound of the sclerotic which has healed leaves an easily recognized cicatrix. The newly formed fibres run from without inwards more or less at right angles to the direction of the normal scleral layers. If the choroid is involved, there may be pigment in the cicatrix, and this is generally in the form of scattered dark particles. If the retina also has been injured, its structure is replaced locally by the fibrous tissue joining the sclerotic, choroid, and retina.

Thickening of the Sclerotic.—As a result of long-continued sclerotitis the thickness of the membrane is sometimes considerably increased. In shrunken eye-balls, where extensive changes have occurred inside the globe, and the sclerotic no longer encloses so large a cavity as formerly, this tunic is often found greatly thickened; and towards its inner aspect there are bends and folds, while the course of the fibres, following for the most part this altered contour, is exceedingly wavy.

Atrophy and Thinning of the Sclerotic.—Another result of chronic inflammation, or of prolonged increase in the tension of the globe, or of obscure degenerative and weakening changes, is atrophy of the sclerotic with bulging outwards. Pathological conditions with thinning are always present in the uveal tract as well, so that the process is perhaps rather a sclero-choroiditis, and the choroid is united to the sclerotic at the protruding part, constituting *staphyloma scleræ*. Here the retina also is adherent, bulged, and atrophied; or it remains free and passes across the protrusion unaffected; or its outer layers are œdematous, and their swelling fills the space; or finally inflammatory material occupies the interval between the retina and the choroid. So far as the sclerotic is concerned, the only change is stretching with reduction in thickness. The most important of such alterations is staphyloma posterior, which is considered among the diseases of the choroid.

Calcareous Deposit in the Sclerotic.—A deposit of calcareous material is now and then found in the sclerotic of old people and also in cases of atrophied eyeballs.

Tumours of the Sclerotic :—

Fibroma.—A fibrous tumour, in which many cells were present, has been described by Saemisch.

Osteoma.—A small plate of bone was found on the outside of the sclerotic, between the superior rectus and internal rectus muscles, by Watson.

Cysts have been observed in the sclerotic by Hasner.

IRIS.

I NORMAL STRUCTURE.

WHEN the posterior pigment layer is brushed off, and the anterior surface of the iris is viewed with a low power, the general arrangement of its superficial part can be observed, and occasionally even deeper layers also. In some cases or at some places the opacity of the object may be so great as to forbid satisfactory examination, but in other instances or at other parts the tissue may be much more clear, and its nature render observation easy. In such circumstances a dark ring surrounds the pupil, indicating the position of the sphincter pupillæ muscle. Cords and bundles of the stroma pass from this at different depths in a radiating fashion to the periphery or root of the iris, and closer investigation reveals some of these bundles starting from the edge of the pupil, and running in front of the sphincter. They are of various thicknesses, and divide and unite frequently; and the intervening spaces or depressions, which differ much in size and depth, are more or less circular, or oval, or lozenge-shaped, or quite irregular. They are shorter and wider when dilatation of the pupil has left the iris somewhat narrow, and more elongated when contraction of the pupil has left the iris rather broad with closer approximation of the bundles. Their distribution is generally looser and more divergent towards the pupil, and more uniformly dense and parallel about the periphery. The meshes are large and subdivided in some eyes, while in others the ridges and cords are rather regularly radiating. The surface is thus exceedingly rough, with numerous hollows and furrows between the elevations. At a greater depth the blood-vessels, the walls of which are thick considering the size of their lumen, form dense bands with a wavy and undulating radial course, dividing and anastomosing near the pupil.

The shape of meridianal sections, extending from the pupil outwards, presents some features which are pretty constant. The pupillary edge is thinnest at its posterior border, and from this the outline passes obliquely, and either fairly straight or with a slight convexity, towards the anterior surface, which does not come so near the pupil as the posterior one, ceasing rather at a little distance from it. The sloping portion then joins the anterior surface at an angle, which is rounded off, so that in many cases the two pass insensibly into one another; and it is at this point that the iris attains its greatest thickness. The anterior boundary line is very uneven, owing to the irregularities already described. Towards the ciliary border there is a series of large, prominent, rounded elevations, varying in number from two or three to about six; and these are due to the presence in this region of concentric ridges, which are seen cut across in such sections. When the periphery is reached, the outline bends forwards at the iritic angle or angle of the anterior chamber, where the root of the iris is connected with the margin of the cornea. The posterior surface joins the edge of the pupil at a somewhat acute angle, and, owing to the shelving or slanting form of the margin, extends further towards the centre of the pupil than the anterior surface. There may be a slight bulging backwards near this, but it is often absent. Otherwise the thick line of pigment at the back of the iris is comparatively straight, although the surface has most frequently a row of small rounded projections. At the periphery the outline bends backwards, and is merged in that of the ciliary processes; and the iris is usually thin at this part. In tangential sections near the ciliary region, there may be found prominences on the posterior surface, which are cross sections of radiating ridges, representing prolongations of the ciliary processes; and similar but much less clearly defined eminences are sometimes seen a little nearer the pupil.

The iris is mainly a structure of connective tissue, rich in branched corpuscles.

The anterior surface is said to be covered by a single layer of somewhat flattened granular epithelial cells, corresponding with the posterior epithelium of the cornea. Such an epithelioid layer can be demonstrated by staining with silver in the case of some animals, notably the albino rabbit; but its presence is not so certain in the human eye. In children traces of such cells can be observed; but in adults, if normally present at all, they must be very generally lost in the preparation of specimens, although some appearances in pathological conditions do rather indicate their occurrence. The anterior layer of the stroma is so crowded with cells pressed together, that the detection of a distinct layer would be very difficult in sections.

The most striking and obvious character of vertical ections is that almost the entire thickness is composed f a very spongy and ragged mass of *stroma.* This has ome fibres of connective tissue ; but consists chiefly of ranched corpuscles, both spindle-shaped and stellate, ith oval or round nuclei. The processes of neighbourng cells unite and interlace freely ; but as the cells re flattened, and lie with their surface parallel to that f the iris, they are mostly seen in profile in vertical ections, and then appear spindle-shaped, while their onnections with one another are indistinct or invisible. They form a loose network, in the meshes of which e larger and smaller, round, granular, nucleated cells. The tissue is more dense towards the anterior and poserior surfaces, and the corpuscles are specially numeous and closely packed in front. The corpuscles may ontain pigment in various degrees ; but, as a rule, it not in large quantity. In the "blue eye" of a fair erson, there is little or no pigment in the stroma, lmost all the corpuscles being quite destitute of it, and ne few which are pigmented being light brown in olour ; but in the iris of a negro the opposite extreme observed, both in the abundance of the pigmented ells and in the depth of the shade, and the coruscles appear almost swollen with dark-brown colourng matter, which may be rather a stain diffused hroughout the cells, and different in character from he granules, into which the uvea breaks up. In eyes ith a moderate amount of pigment the cells lying ose to the anterior surface are much more largely upplied than those more deeply placed, and the proesses of the branching corpuscles are sometimes specially easily and clearly defined owing to the presence of the coloured particles. There are generally some large, spheroidal, darkly pigmented cells scattered both in front of and behind the sphincter pupillæ muscle, and they are frequently more abundant on its posterior aspect.

At the periphery the stroma is continued forwards, and intimately mingled with the fibres and membranes of the ligamentum pectinatum, while posteriorly it is directly continuous with a mass of tissue similar to itself, occupying the internal portion of the ciliary body round the anterior and inner margin of the ciliary muscle.

The main *blood-vessels* are situated about the middle of the thickness of the iris, and a considerable amount of the connective-tissue fibres is associated with them, forming part of their adventitia, and rendering them conspicuous. Their connection with the circulus arteriosus iridis major in the ciliary body may be seen. There are also some prominent bundles of fibres at the root of the iris, passing into the matrix of the ciliary body and among the trabeculæ of the ligamentum pectinatum.

In ordinary sections the *nerves* do not seem numerous; but fibres can be distinguished here and there, more especially in the neighbourhood of the blood-vessels and about the posterior surface.

The *sphincter pupillæ* is a ring of unstriped or smooth muscular fibres round the pupil; and in meridianal sections, where it is cut transversely, it forms a rod of dense material, compared with the loose stroma, varying in shape and size, close to the posterior surface at the margin of the pupil.

Behind the general mass of the stroma, and immediately in front of the uvea, there is a continuous delicate sheet of nearly straight and almost parallel *radiating fibres*, which are composed of involuntary or unstriped muscular fibre cells with their usual elongated nuclei. Both at the pupil and at the ciliary margin their course, as seen in surface views of brushed specimens, is in divergent bundles, which in some instances show a tendency to form loops. The elements of this layer have been variously described as constituting a dilatator pupillæ muscle, as connective-tissue spindle cells, and as a membrana limitans or basement membrane.

The *uvea* or pigment layer, which covers the back of the iris, appears in vertical sections as a broad black band, and at cracks or at the margins of the line the component particles of pigment are seen cemented together; but individual cells can nowhere be distinguished. In surface views of brushed specimens, however, the remains of this layer are found as large roundish or polygonal cells crammed with dark-brown granules. When the posterior surface of an unbrushed iris is examined with a low power, the pigment layer may in some cases be observed to be composed of a number of concentric ridges, and these again are divided up into portions, so that the rings are by no means complete, but are made up of a series of curved or slightly crescentic pieces of different lengths, running parallel with the edge of the pupil, and ending in blunt points, which fit in between similar ridges on either side. Often, however, the posterior surface of the uvea is simply a somewhat uneven mass, in which no such configuration can be seen, and no division into ridges with shallow intervening furrows can be traced. In meridianal sections the uvea extends from the pupil to the periphery, where it is continuous with the pigment layer of the ciliary processes. It generally reaches slightly round the edge of the pupil, and may even cover the sloping margin for a very short distance. Its anterior boundary line is smooth and even; but posteriorly it has commonly a number of small nodules or hemispherical swellings, differing in size and height, which are transverse sections of the concentric ridges just mentioned.

II. PATHOLOGICAL CONDITIONS.

Iritis.—In preparations from eyes, in which there is inflammation of the iris, there are locally the usual evidences of an inflammatory condition, such as thickening, swelling, or change of shape, distended hyperæmic blood-vessels in the midst of little knots of round cells, or larger areas of inflammatory exudation, or further changes in an infiltration, tending to the formation of some variety of fibrous tissue or to destruction by suppuration. The influence and effect of such alterations upon the iris itself, upon the adjacent structures, and upon the relations of the iris to the latter, give something special to almost every case which comes to microscopical examination; but three forms of iritis, based upon the main characters of the exudation, may be described, although they cannot be entirely separated from one another, owing to the presence of features common to them all.

Plastic or Simple Iritis.—In this, which is the most usual variety, the iris is infiltrated with round cells to a moderate extent, and there is at some part of its surface an inflammatory exudation with characteristic effects. It may be at any place, in front, behind, or about the pupil. If recent, it is composed of fibrine and leucocytes, and clinical observation shows that this either is absorbed or becomes organized. All the steps of the latter process are seen in different cases, according to the stage which has been reached, or many of them occur in one specimen. At an early date the exudation is found to be infiltrated with a large number of round cells among the strings of the fine fibrinous network; at a later date the locality is occupied by a membrane formed of delicate fibres, spindle cells, round cells of different sizes, and collections of pigment either as free granules or confined in cells; at a still later date the membrane is densely fibrous, and has fewer cells. The effects of the exudation are most marked about the posterior surface of the iris, the common result being adhesion of the uvea to the capsule of the lens, a condition known as *synechia posterior*. In simple synechia the uvea is joined to the capsule by means of a small quantity of amorphous material; in membranous synechia the union is effected by organized tissue, which may be merely a thin line in sections, or form a thick layer. Circular or annular synechia, where a ring of the iris round the margin of the pupil is adherent to the lens, forming what is called *exclusion* of the pupil, leads to accumulation of fluid behind the iris, which is then bulged forwards, producing a funnel-shaped pupil. In sections of such globes the distended posterior chamber is empty, or is filled with a clear, slightly granular, coagulated mass; and the pressure from behind, produced in this way, if it has been long continued, may be found to have caused stretching, thinning, and atrophy of the iris. A pupillary membrane, which is present in the condition known as *occlusion* of the pupil, affords a good example of the results of organization of iritic exudation. The pupil is blocked by a layer of fibrous tissue, containing cells of various shapes and frequently some pigment; and the border of this slightly overlaps and embraces the edge of the iris, in which thinning, or atrophy, or distortion of some kind may have been produced by the contraction and dragging of the membrane. In total synechia posterior, where a very large extent or almost the whole of the iris is adherent to the capsule of the lens, it may be difficult or impossible to make out a definite layer between the two over a wide area, or, on the other hand, a comparatively bulky, vascular, fibro-cellular membrane may have replaced the original exudation, and bound the surfaces firmly together. Great changes are then seen in the uvea. It is sometimes very thick and uneven, with projecting processes extending into the inflammatory material, or it is broken up, and fragments of it are lodged in the newly formed tissue as masses of very irregular form, or as scattered free particles, or as pigmented cells. It is often extensively detached and carried away from its normal position to some distance; or, in instances where there are large posterior synechiæ, it may be separated at intervals from the rest of the iris, so as to leave a series of intervening cystic spaces, which contain inflammatory products of various kinds, such as coagulated material in small, rounded, highly refractive knobs along with large clear vesicles, granular amorphous substance, fibrine in strings and small vesicles, red blood corpuscles, round cells of various sizes, pigmented cells apparently derived from the uvea, or cells with blood pigment in the form of brownish granules both large and small. These last seem to be examples of pigmentation of cells from absorption of red blood corpuscles into their interior with subsequent shrinking, contraction, and degeneration of the blood corpuscles, the ultimate result being the production of a large spheroidal cell, inside the clear outline of which lies a variable number of reddish-brown granules, some of considerable size, amongst which a round nucleus can occasionally be demonstrated by staining. These are the changes described in connection with this form of pigmentation from hæmorrhage elsewhere, and many inflammatory conditions in the eyeball accompanied by local hæmorrhage show these pigmented cells, which occur not only in the products of iritis, but also in the inflamed ciliary body, in membranes formed behind the lens in cyclitis, in the inflamed choroid, near choroidal extravasations, and in the retina detached by extensive sub-retinal hæmorrhage or altered by atrophy.

Purulent Iritis.—In cases of suppurative iritis there is often merely a layer of pus on the anterior surface of the iris with some infiltration of round cells in the stroma. In purulent panophthalmitis, again, there is widespread purulent iritis with a profuse collection of round cells in the swollen or distorted iris, while pus cells and leucocytes entangled among strings of fibrine are accumulated in the anterior chamber, producing the condition called clinically *hypopyon*. The stroma of the iris is entirely obscured by the infiltration, or replaced by a mass of round cells, cemented together by a granular fibrinous coagulum. The normal corpuscles are destroyed, and the uvea broken up, so that in the midst of the crowded leucocytes there are disintegrated pigmented cells, free granules of pigment, and masses of the uvea, along with compound granular corpuscles, clear vesicles, and molecular débris. In such cases other parts of the globe are inflamed also, the ciliary body, the choroid, the vitreous, and the corneo-scleral junction being more or less infiltrated with round cells. In specimens from a later stage the iris may be represented by an atrophied membrane, or by fragments of its original tissue such as the sphincter muscle, or merely by some collections of pigment.

Inflammatory Œdema of the Iris.—In eyes affected with "serous iritis" the most characteristic features are those of inflammatory œdema. The tissue of the thickened iris is looser than normal, and some of its spaces are filled with a gelatinous-looking finely granular substance, which is sometimes stained a yellowish colour by dissolved blood-pigment. The number of inflammatory round cells present is limited, both in the iris itself and in the surrounding exudation. If the margin of the pupil has become adherent to the capsule of the lens from the formation of annular synechia, the iris may be pressed forwards, and the distended posterior chamber is empty or occupied by a finely granular mass, the surface of which, as seen in thick sections, is nodulated, while in thin sections its margin is scalloped, and recalls the appearance of the layer of coagulated serum which is sometimes found between the central clot and the wall of hyperæmic blood-vessels, cut across in preparations of other inflamed tissues after hardening. The posterior epithelium of the cornea generally presents some changes either of proliferation, or of degeneration, or of partial destruction, conditions referred to in connection with descemetitis and keratitis punctata. In some preparations there are appearances, which favour the view that there is a proliferation of epithelial cells on the anterior surface of the iris in iritis, for there are round corpuscles here, the large size of which suggests an epithelial origin. In some of them there is a divided nucleus; in others the cell has a constriction about the middle between the nuclei; in others this constriction is represented by a filament, connecting the two parts and giving them a pyriform shape, and rupture of this filament would set free two of the large, round, granular, nucleated corpuscles. In serous iritis inflammatory round cells are frequently found in the neighbourhood of Schlemm's canal and elsewhere, as, for instance, in the sheaths of the vessels of the retina and at the optic disc. Clinically the changes in serous iritis are found to end in resolution, or to become chronic and result in atrophy.

Wound and Prolapse of the Iris.—A wound of the iris almost necessarily implicates the cornea, and very often involves the lens as well. Some of these complicated injuries have been considered among the pathological conditions of the cornea, and others present features the most prominent of which belong to inflammation of the ciliary body. As a rule, therefore, specimens show changes in the surrounding parts in addition to the local circumscribed inflammation or destruction of the iris; and the results are often so extensive, that the former presence of the iris may be chiefly indicated by the remains of the uvea, embedded in a mass of pus or in a cicatricial membrane, according to the occurrence of purulent or plastic iritis. In simpler recent cases the injured portion of the iris is the seat of an exudation of round cells, and may be glued to the cornea in front or to the capsule of the lens behind. Such adhesions lead to displacement, and, by the ultimate formation of organized tissue, to very great distortion or atrophy of the iris. Where there is prolapse of the iris through an opening in the cornea, the portion which passes into or through the wound may be large or small, readily recognizable as the iris, or only revealing its origin by some few characteristic elements. It may plug the opening, or constitute a small part of an inflammatory mass in the gap, and small growths of granulation tissue are occasionally found on the exposed portion. A foreign body may be lodged in a wounded iris, and, if this is a fragment of the margin of an eyelid, such as part of an eyelash or a sebaceous gland, the imported cells may proliferate, and produce a minute cystic tumour with epithelial and fatty contents (Krause).

Atrophy of the Iris.—The iris is found atrophied after inflammation, after stretching produced by the effect of adhesions between it and the neighbouring parts, or after prolonged excessive intra-ocular pressure as in anterior staphyloma and glaucoma. When partially atrophied, it is reduced in thickness and unduly fibrous; in an advanced stage it is a thin membrane, composed entirely of pretty dense fibrous tissue with an occasional cell or nucleus, a few blood-vessels, and some granular material. Pigment is sparsely scattered about as free particles, or appears more abundant than usual from the contraction of the area, throughout which it was previously spread. The sphincter muscle seems to be unaffected for a considerably longer time than the other tissues, and the uvea, which is not so much atrophied as dispersed and destroyed, often remains unchanged, although the pigment of the stroma has disappeared. When the atrophy has arisen from long-continued pressure, as in staphyloma of the cornea, fragments of the uvea are sometimes the only elements which are left. An atrophied iris may be increased in thickness, the expansion being caused by the dragging effect of adhesions to adjacent parts, and it is then a loose structure, in which there is a large amount of connective-tissue fibres with wasted and degenerated corpuscles. In the stumps of shrunken eyeballs the former situation of the iris is occasionally represented by a small thin plate of fibrous tissue.

Tumours of the Iris :—

Granuloma.—In addition to the granulations which are observed on the surface of a prolapsed iris in some instances, small nodules of granulation or round-celled tissue have been found on the iris. They may be richly supplied with blood-vessels, and contain some spindle-shaped cells, giant cells, and connective tissue (Hirschberg and Steinheim).

Tubercle.—A tubercle in the iris consists of a collection of round cells with giant cells (Gradenigo).

Gumma.—In the mass of round cells, which form the bulk of a gumma of the iris, the central region may show the amorphous granular condition of caseous degeneration, while the margin is composed of spindle-celled and connective tissue (Colberg). Clinically it is known that a gumma ends in resolution, or, after absorption, leaves a circumscribed area of atrophy.

Melanoma.—A small tumour of the iris, made up of some non-pigmented and many pigmented branched corpuscles of the stroma, has been described under this name by Knapp.

Sarcoma.—Various forms of sarcomatous tumours of the iris have been examined. The tissue may be spindle-celled and non-pigmented (Kipp); or melanotic, and composed of spindle-shaped cells without pigment, mixed with spheroidal and polygonal pigmented corpuscles (Hirschberg); or consist of pigmented round cells (Knapp).

Cysts.—Small cystic tumours occur in the iris, and seem to be originated by injuries. The thin wall of the cyst is formed of the stroma of the iris, much stretched and thinned; and the cavity is filled with clear fluid (Wecker).

Angioma.—A small "cavernous" tumour of the iris has been recorded by Schirmer.

CHOROID AND PIGMENTED EPITHELIUM.

I. Normal Structure.

The choroid, lying between the sclerotic and the retina, is thickest in the neighbourhood of the optic disc, and becomes thinner towards its anterior margin, where it is continuous with the ciliary body. It is a membrane composed of connective tissue, richly supplied with blood-vessels and pigmented cells, the pigment being the most prominent feature in a surface view, and the blood-vessels occupying most of the field in a vertical section.

When it is examined from the inner surface under a low power, the vessels form clearer lines, so distributed as to leave elongated meshes; and in the latter are found dark masses of accumulated pigmented cells. The distinctness of this configuration is toned down or obscured, when the pigmented epithelium has not been removed. If the portion happens to include a vena vorticosa, the branches of the vessel and the intervening spaces have a stellate arrangement.

In vertical sections the general appearance is very much that of a mass of blood-vessels cut longitudinally, obliquely, and transversely, bound together by fibres, among which it is difficult to define the walls of the vessels. It is a loose tissue with many and large holes.

The inner part contains a multitude of minute vessels and capillaries, and is called the *membrana chorio-capillaris* or *membrane of Ruysch*, while the larger vessels with the greater part of the stroma pigment are in the layers external to this.

The *stroma* is formed of a close felt-work of delicate white and elastic connective-tissue fibres, amongst which smooth muscular fibres have been seen (Iwanoff). Leucocytes are scattered throughout it, and form here and there little collections resembling adenoid tissue. Some of the connective-tissue corpuscles contain no pigment, and are either large, round, and granular, or flattened, irregular, and branched. For the most part, however, they are pigmented, in which case the cells —which may be roundish or spindle-shaped, but are generally of very irregular form, flat, and branching —are filled with brown granules, the dense packing of which may make the cell appear black. The pigment varies greatly in shade and quantity in different people, and even at different parts of the same eye. It is paler in fair persons and darker in those with dark hair and in the dark races; and sometimes the shade is lighter in the inner than in the outer layers of the choroid. The nucleus usually appears as a clearer spot about the centre, and stains deeply. The processes of the corpuscles are long or short, thick or thin, tapering or club-shaped, undivided or branching, numerous or few, and frequently unite with those of the neighbouring cells. These cells are chiefly in the outer strata of the membrane, and, as they are placed with their flat surfaces parallel with those of the choroid, it is a side view of them which is obtained in vertical sections.

There are many *nerve fibres*, forming a plexus, with granular ganglionic *nerve cells;* and, towards the sclerotic, portions of the ciliary nerves, as they pass forwards, are often seen in sections, thin, branched, pigmented corpuscles being occasionally found between the fibres of a nerve bundle.

Staining with silver brings out the ordinary endothelial lining of the abundant *blood* and *lymphatic vessels;* but it is sometimes difficult to determine the precise nature of a given vessel in such preparations in the human eye.

Externally, there is a thin membrane with many of the characters of the choroid, of which it seems to be the outer layer. This is called the *lamina suprachoroidea*, and is formed of delicate connective tissue and elastic fibres, with corpuscles of many kinds, mostly pigmented. Some of these are large and branched with short processes, or smaller with longer and thinner processes, while others have no branches, and form irregular plates. The possession of pigment makes all of them much more conspicuous than the pale, round, granular, nucleated, lymphoid cells, of which there are always a few present. The lamina is covered by a layer of epithelioid cells, forming the inner wall of the *perichoroidal lymphatic space*, the outer wall of which is the lamina fusca inside the sclerotic.

Internally, the choroid is bounded by a smooth, homogeneous, transparent membrane, the *lamina vitrea* or membrane of Bruch, directly continuous with the layer of similar structureless material in which lie the capillaries of the chorio-capillaris.

Sattler has described perivascular lymphatic sheaths, and also an elastic layer between the capillaries and the larger vessels, divided by a space, which is lined on the opposing surfaces with endothelium.

Pigmented Epithelium.—Resting upon the lamina vitrea there is a sheet of pigmented epithelium, formerly described as part of the choroid, but now, in consideration of its development from the outer wall of the optic cup, regarded as belonging to the retina. It is most conveniently discussed in connection with the choroid, to which it generally adheres in examinations of the eyeball, and in whose fortunes it largely shares in disease.

It is a single layer of thick, flattened, polyhedral cells, which, seen as they lie in flakes, are of varying but pretty uniform size, and of fairly regular hexagonal shape. In such preparations the nucleus is usually hidden, but it is sometimes visible as a clearer or quite clear spot at any part of the cell, often towards one side. When seen sideways, the cells are found to differ in their outer and inner halves; the former, next the choroid, is clear, highly refractive, nearly or altogether without pigment, and contains a round nucleus, which stains readily; the inner part, on the other hand, next the retina, is more or less crowded with oblong brown particles. As in the choroid, so here also the tint of the pigment is in keeping with that of the rest of the body; in fair persons it is comparatively light brown, in dark persons and races it appears almost black. The cells are joined together by a transparent cement-substance, which stains with nitrate of silver in the usual way of such intercellular material, and occasionally occurs as fragments of a network in preparations where the cells have dropped out. According to Schultze and others, delicate processes extend from the internal surface of the cells among the rods and cones of the retina.

In the majority of sections this layer forms a perfectly opaque band, in which no division into cells can be distinguished; the inner border is rough, and individual particles of pigment are seen there; and occasionally the clear outer portion is quite distinct, with the nuclei lying in it at nearly regular intervals.

II. PATHOLOGICAL CONDITIONS.

Hyaline Excrescences of the Lamina Vitrea.—The presence of small, hard, warty projections on the internal surface of the lamina vitrea may be a senile change or the result of choroiditis; and the condition is known as *colloid disease* or *colloid degeneration*. These little bodies have been found in the eyes of the young (Alt); and they occur at any part of the choroid or on the ciliary processes. They are clear and strikingly transparent in the midst of the surrounding tissues, and range in size from minute points to considerably larger growths. If single, they are hemispherical, round, or oval; while, if united into small groups, the form of the compound mass with its uneven outline resembles that of a gland, and such nodules are called *Glasdrusen* by the Germans. They have sometimes concentric lines in sections, and the larger aggregations thus look like fragments of decalcified bone. They may be somewhat fibrous, or contain particles of pigment or granular material, or be the seat of calcareous deposit.

The pigmented epithelium is pushed forwards before the growth or to the sides; in the former case the projection is covered, and in the latter the most prominent portion is bare, while an accumulation of pigment surrounds the margin and base. The furrows and depressions of the larger compound excrescences are so occupied, and the other parts are exposed.

Under a low power an area of the choroid affected in this way seems studded with clear openings, where the absence or disarrangement of the pigment is well marked; but focussing shows that such spots are prominences encircled by a dark ring, while the epithelium as a whole may be greatly atrophied and destroyed.

The glassy bodies are sometimes detached and embedded in a diseased retina, and, if the retina is itself detached, they may be found in it at a distance from their place of origin.

Intra-choroidal Hæmorrhage and Pigmentation.—Rupture of some blood-vessel, as, for example, after a blow on the eyeball, leads to extravasation of blood in the choroid, and the hæmorrhage is either diffused throughout the tissue, or a clot occupies a space between two portions, an inner and an outer, of nearly equal thickness, into which the choroid is split.

In the neighbourhood of extravasations, and also in cases where there are evidences of inflammation of the choroid, such as a fibrinous coagulum and some round cells, without any blood clot, a number of pigmented cells, of the kind referred to under "Iritis," may be found. These present the appearance of clear vesicles, containing a variable number of large granules, which are reddish-brown or very dark brown in colour, and are often of comparatively uniform size. Similar granules and much more minute particles are generally scattered about, singly or in little groups.

Detachment of the Choroid.—A detachment or displacement of the choroid is frequently observed in eyes which have been enucleated. It may be circumscribed or widespread, and the distance between the choroid and the sclerotic small or considerable. The space is occupied by a sub-choroidal effusion of blood, or by ome fluid, which is usually yellowish in colour, and contains cellular elements and remains of pigment, or by granular coagulated material, portions of which cling to the walls of the cavity in sections after hardening. A common cause of detachment is the dragging produced by cyclitic membranes, and the interval between the sclerotic and the choroid in such cases often contains inflammatory products, the chief of which is fibrine in the familiar intricate network of bright strings.

Hyperæmia and Œdema of the Choroid.—Œdema of the choroid may merely render the tissue excessively loose and spongy with empty spaces; but more frequently, as seen in hardened eyeballs, it leads to obliteration of many of the normal characters. When there is hyperæmia, as shown by distension of the vessels with blood corpuscles, it is not uncommonly found that the fibrous structure is greatly disguised. The sections are peculiarly glassy, and the vessels occur collections so entangled and confused that it is impossible to trace their relations. In other instances the membrane is increased in thickness, and sections of show nothing but a transparent, glancing, and granular mass, in which there are round and oval openings corresponding with the position of the vessels, while the pigmented cells of the stroma lie in rows. The coagulated material, with which the choroid is thus extensively infiltrated, has vacuoles, and is frequently stained yellow with dissolved colouring matter from the blood. Accompanying this condition there may be similar serous or fibrinous material with a few round cells outside the choroid, separating it from the sclerotic, or on the inner surface, when there is detachment of the retina, and the pigmented epithelium adheres either to the retina or to the choroid. Such effusions assume varied appearances in preparations from eyes which have been submitted to the action of hardening reagents. There may be only traces of the fluid in the form of granules, or the space may contain a large coagulum, and this is either structureless and almost clear, with a scalloped and vacuolated edge, or it is much more opaque and made up of short fibres like dense fibrine, or it is a collection of bright highly refractive knobs. The arrangement of the pigmented epithelium is sometimes altered, or the cells are somewhat pale and bleached looking.

Plastic Choroiditis.—In ordinary cases of choroiditis the changes are confined to separate spots; but the affected areas may have united, or the inflammation be more diffused. There are hyperæmic blood-vessels and inflammatory exudation of serum, fibrine, and round cells, the last being confined to, or specially numerous in, the neighbourhood of the vessels. In addition, there is often a profusion of pigmented cells which contain dark-brown particles of the normal kind or larger, or reddish-brown granules, as in localities where there has been hæmorrhage. The pigmented cells of the stroma may possess no processes, and form roundish bodies with larger particles of pigment than usual; and they may show the successive stages of division and proliferation. Some œdema is frequently present. The pigmented epithelium is generally thinned, disarranged, or wanting over the place of disease; and at the margin there is an accumulation of particles of pigment, either in cells or lying free.

The lamina vitrea has occasionally hyaline excrescences on its surface.

At a later stage the inflammatory exudation is replaced by connective tissue, and locally the choroid is fibrous, atrophied, and thin, being either deficient in, or destitute of, pigment, or containing clumps of it in the cicatricial tissue or in the immediate neighbourhood.

If the exudation has passed through the lamina vitrea, it lies under the pigmented epithelium, the rods and cones of the retina being altered or destroyed, or it is mingled with the remains of the broken-up pigmented cells, and forms a layer between the choroid and retina. If it has penetrated into the retina, there is an interstitial inflammation of the latter, constituting *choroido-retinitis* with, as a rule, ultimate formation of cicatricial tissue and adhesion between the two membranes over the area involved. The consequent atrophy of the retina may be confined to the outer portion, extending no further inwards than the external nuclear layer, and some cells from the pigmented epithelium, which is absent at the place of adhesion, are found in the retina.

In *retinitis albuminurica* the condition of the choroid indicates in many specimens a certain amount of inflammation, such as an œdematous and spongy character with empty spaces or masses of coagulated serum, or an increase in the number of leucocytes. In more advanced cases of Bright's disease some of the choroidal blood-vessels have thickened walls, which are clear and conspicuous in sections.

Purulent Choroiditis.—This is almost always diffuse, and is recognized by the large number of round cells throughout the choroid with an intercellular granular coagulum. There is great thickening and swelling of the part, with destruction of the proper structures in the later stage, although the pigmented cells of the stroma appear for long, and in the midst of many marked alterations, apparently unchanged. Ultimately there is nothing but a mass of round cells with scattered collections of pigment. The lamina vitrea is generally interrupted, and the pus found spreading into the interior of the eyeball at some place; and the retina is thus infiltrated, or separated from the choroid by an accumulation of granular and vacuolated amorphous substance into which the pus extends. In the earlier stages the pigmented epithelium is unchanged, or shows signs of breaking up with dispersion of the dark particles; but in other cases it is considerably thickened or entirely absent. It may be pushed inwards along with the lamina vitrea by an accumulation of pus in the inner layers or chorio-capillaris, while the outer layers of the choroid remain intact. The inner layers of the sclerotic, if attacked, are infiltrated with round cells.

Suppurative choroiditis is usually part of purulent panophthalmitis; but the result is sometimes chronic inflammation, and specimens may come for examination, which have reached a very advanced stage, with formation of fibrous tissue and atrophy of the globe.

Wound of the Choroid.—At the point of injury there are signs of choroiditis, the form, stage, and effect of which vary in different cases and at different dates. The local condition is perhaps lost or concealed in extensive purulent choroiditis or even panophthalmitis, to which it has given rise; or cicatrization may have taken place, and the wounded tunics of the eye be thus firmly united together. The choroid is then joined locally to the sclerotic, which is pigmented, or to both the sclerotic and the retina, with pigmentation of the tissues about the spot.

Formation of Bone in the Choroid.—Chronic choroiditis of any kind is now and then followed by the formation of a fibrous membrane on the inner surface, in which, or under which, there lies either a calcareous deposit among the fibrillated material or a plate of bone with the usual irregular trabeculæ, intervening spaces, lacunæ, and canaliculi, and occasionally surrounded by osteoblasts. This also occurs along with the presence of hyaline excrescences of the lamina vitrea. A lamella of bone is sometimes found under the lamina vitrea and occupying the whole thickness of the choroid, its size varying from a very small nodule to a plate of some thickness and extending over a considerable area. In a large scale at the fundus there is a perforation corresponding with the normal aperture in the choroid, allowing the passage of the optic nerve fibres, and in other examples the optic disc is surrounded by a ring of bone. The lamina vitrea is generally distinguishable, even although widespread changes have caused destruction of the other choroidal tissues.

Atrophy of the Choroid.—An atrophied choroid is a thinned fibrous membrane, from which all pigment has vanished, or in which bands of pigment render the details of the dense tissue very obscure in sections. Choroiditis commonly causes the former condition; prolonged intra-ocular pressure often results in the latter. The degree of atrophy ranges from a slight thinning with increased density to almost total destruction of the normal appearances, there being few cells present, and the blood-vessels not being visible, while in extreme cases there may be no characteristic elements in the situation of the choroid.

Over a white non-pigmented spot the pigmented epithelium is wanting; but the adjacent cells are very dark, and the layer generally shows an increased thickness here. The pigmented cells of the stroma surrounding such an atrophied portion seem more conspicuous than usual, and amongst them lie masses of dark particles. If the atrophied choroid is simply condensed, the pigmented epithelium is frequently unaltered.

Where the choroid is undergoing disintegration and destruction, as, for instance, when it is being invaded by a malignant growth, numerous fatty cells occur in groups, which are derived from the corpuscles of the stroma, either those with or those without pigment. All degrees of the change are seen, from a few glistening fatty granules in the body of the cell to distension of the corpuscle with bright shining globules. One part of a cell may show normal pigmented contents, while another part has little molecules of oil. If the cells break up, their contents are dispersed throughout the neighbourhood.

Staphyloma Posterior.—This is a localized bulging backwards at the fundus. It is almost always at the side of the optic nerve next the macula lutea; but it sometimes encircles the disc, and then similar changes are found on each side of this in sections. There is thinning of the sclerotic and atrophy of the inner tunics, all the membranes bending outwards, and being occasionally united together. In vertical sections including the optic disc in a well-marked case the somewhat thinned sclerotic has a greater curve at the protruding spot than in the rest of its extent, and is placed further back than the opposite unaffected side of the disc. In normal circumstances a ring of the sclerotic round the disc is usually thin, the position of this corresponding with the anterior extremity of the interval between the junction of the sclerotic with the inner sheath of the optic nerve and the point at which the outer sheath unites with the scleral layers. In staphyloma posticum this part is stretched, and the end of the inter-vaginal space is often prolonged behind the staphyloma for a short distance from the optic nerve. Vessels passing through the staphylomatous region of the sclerotic are sometimes affected; but they are not always obliterated, nor are the nerves destroyed. The atrophy of the choroid is very marked; and in advanced cases there is only a thin, dense, fibrillated membrane, with neither corpuscles, nor pigment, nor vessels. The pigmented epithelium is absent over this area, which, when confined to its usual locality at the side of the disc, is called from its shape, as seen with the ophthalmoscope, the crescent. At the outer border of the crescent, however, the pigmented epithelium is frequently accumulated into a small dark heap, and here there are also round epithelial cells with little or no pigment. The plane of the inner surface of the disc may be oblique. The retina is atrophied locally to a greater or less degree; and, when glaucoma has accompanied the staphyloma, the disc is excavated.

Tubercle of the Choroid.—The presence of a tubercle in the choroid causes a circumscribed swelling or prominence, composed of a collection of round cells in the stroma. Giant cells may be found in it (Alt); and the occurrence of the bacillus tuberculosis has been demonstrated several times. The pigmented epithelium either covers the little tumour, or is absent to some extent over it. Part of the mass may have undergone caseous degeneration (Manz). The disease also occurs as a general tuberculous infiltration of the choroid (Poncet).

Granuloma of the Choroid.—Minute granulations, composed of round-celled tissue, may form on the choroid, and project inwards. They occur after wounds (Alt), or along with trachoma of the eyelids (Leber); but do not constitute granulation tumours in the strict sense of the term, although they have been recorded under that name.

Cysts of the Choroid.—Small cystic spaces in the periphery of the choroid, with a thin wall lined by endothelial cells, have been described by Alt, which were possibly distended lymphatics.

Angioma of the Choroid.—Panas has described a small cavernous tumour, occupying the whole thickness of the choroid, at a spot near the disc, under this name. It consisted of fibrous tissue with numerous minute spaces filled with blood corpuscles.

Sarcoma of the Choroid.—Several varieties of sarcomatous tumours, round-celled, spindle-celled, non-pigmented, or melanotic, spring from the inner and outer layers of the choroid. The round cells are small or large, and so also are the spindle cells; the branched cells are very irregular; and the different cellular forms may be found in separate districts of the same tumour. The characters and course of the disease differ accordingly, just as in other parts of the body. The intercellular substance is, as a rule, exceedingly scanty; but in some cases it is more noticeable, and even gives the growth an alveolar structure, resembling carcinoma. The blood-vessels are abundant, and are often without apparent walls, rather forming canals through the tissue; if specially numerous, the tumour has a cavernous appearance.

In the earlier stages, or where there is slow growth, there may either be a circumscribed prominence projecting into the interior of the eyeball from the choroid, when the lamina vitrea is broken through, and, if seen at the margins, forms folds there, or the choroid may be thickened over a large extent by a diffused growth. In the later stages the place of origin of the more malignant kinds is quite beyond detection, or the globe is so destroyed that only fragments of it are found in the midst of the irregular mass. When seen as it is spreading inwards, the tumour may be covered with a kind of capsule, which represents the inner layers of the choroid, or these united with the retina, or the retina alone. It is sometimes newly formed; but even when merely fibrous, it may be derived from the previous normal structures, as can be determined at its margin. Fatty degeneration, crystals of cholesterine, fragments of hyaline cartilage, areas with myxomatous gelatinous material, calcareous deposit, and possibly small formations of bone, have been observed in choroidal sarcomata.

Examples of the different kinds of tumours will be most conveniently mentioned separately:—

Round-celled.—This is soft, and consists of masses of round cells. Its distribution and arrangement present many variations. It is very vascular, and fatty degeneration and caseation occur in spots.

Spindle-celled.—Here there is usually a firm tumour, arising from some part of the choroid, and projecting into the vitreous. It is made up of spindle-shaped cells, which are often so bound together by cement-substance that the individual elements cannot be distinguished in sections. The remains of the pigment of the choroidal stroma and of the pigmented epithelium are distributed throughout it, and give it a grey tint darker in certain areas; and pigmented cells are commonly abundant at the outer surface and the margins, especially where the growing tumour passes into the normal choroid. There are narrow vessels with delicate walls through it, and occasionally ill-defined spaces with blood corpuscles or hæmorrhages; but this is much firmer and less vascular than the other forms of sarcoma.

Melanotic.—The component cells of these growths are of various sizes and shapes, spheroidal, spindle-shaped, branched, and irregular, and most of them contain brown granules, the roundish cells appearing specially dark or black. One part of the tumour may be pigmented and another part not so; and cells lying side by side may show great diversity in regard to pigmentation, having either abundant dark-brown particles or being quite free from these. The particles are of different sizes, and are either inside the cells or between them; they are sometimes confined to definite districts, and may be mostly arranged at the margin of the growth or along its base next the sclerotic. Pigmentation from extravasations of blood also occurs.

The neighbouring parts are affected by the sarcomata according to the nature of the tumour. In the less malignant forms or in the early stages, the retina either adheres to the surface of the tumour, or is widely detached by it, or infected and destroyed. Glaucomatous changes in the ciliary region and the optic disc are frequently present. The elements of the sarcoma are found in the blood-vessels and also as groups in the otherwise normal choroid at the edge of the growth. In the more malignant forms or in the late stages all the tissues of the eyeball are liable to show invasion and destruction, so that in an extreme case the normal structures and arrangement of the globe are entirely lost, while the sarcomatous elements have penetrated into the orbit and spread there. Several stages in the extension from within outwards have been observed; if the perichoroidal space is obliterated locally, the remaining edge of the lamina supra-choroidea can be traced for a little distance outside the margin of the tumour; if the sclerotic is attacked, its tissue is found loosened and containing nests and colonies of the tumour cells, or these are present along the sheaths of the penetrating vessels and nerves. Even where this last has been the apparent mode of extension, and secondary tumours have arisen outside the sclerotic, no connection between the intra-ocular and the extra-ocular portions may be discoverable in many sections; but at an advanced stage there may be direct continuity between them over a large extent, the intervening structures having been by that time destroyed. If the tumour spreads backwards, its elements may be seen in the inter-vaginal space and along the sheaths round the optic nerve, or in the substance of the nerve itself, where it seems to involve the supporting trabecular framework in the first place. Suppuration of the cornea with perforation opens another passage to the tumour from within, and the growth has also been observed extending through a corneal cicatrix. Fuchs has described an œdematous condition of the anterior part of the cornea in cases of glaucoma from choroidal sarcoma. Pressure of an intra-ocular tumour may alter the shape, position, or transparency of the lens in various ways; and there may be evidences of cyclitis.

Changes in the Pigmented Epithelium.—In almost all pathological conditions of the choroid the pigmented epithelium is affected, and these alterations have been mentioned in the proper places. The hexagonal form of the cells suffers, and the mosaic appearance is lost; the distribution of the dark particles inside them is disturbed, and the pigment is diminished or wanting;

the cells degenerate and break up, and the granules lie loose or dispersed, or they are partially destroyed or altogether absent. On the other hand, changes of an opposite kind occur. The cells are enlarged and crammed with pigment; they accumulate and form heaps; minute tumours of them even extend into the retina, causing local disorder or destruction of the outer layers of that membrane; or they may pass inwards, and produce what is called pigmentation of the retina. One form of this is found in *retinitis pigmentosa*, where the choroid remains intact (Donders); and similar retinal changes are present in *choroido-retinitis*, specimens of which are got in eyes lost from other deep-seated disease. This is, however, described in connection with the retina.

CILIARY REGION.

I. Normal Structure.

The ciliary region includes the junction of the cornea and sclerotic, the overlying conjunctiva, the ciliary body with its union to the iris in front and the choroid behind, and the pars ciliaris retinæ. The relative positions and proportions of these are most satisfactorily demonstrated in meridianal sections radiating from the centre of the cornea.

Corneo-scleral Junction.—The *anterior epithelium* of the cornea is continued directly into the similar, but thicker, layer of the conjunctiva. In the eye of the negro, brown granules occur in this locality, chiefly in the deeper strata of cells.

The *conjunctiva* usually becomes slightly separated from the sclerotic in preparations, and its histological elements have been already described under "The Conjunctiva Bulbi." The border of the connective tissue extends over the margin of the cornea, and stops as a thin film under the corneal epithelium, this portion with the episcleral tissue forming the limbus conjunctivæ.

Bowman's membrane becomes gradually thinned to a fine edge, the actual termination of which is not sharply defined between the delicate fibres on its anterior and posterior surfaces.

The transition from the *substantia propria* of the cornea to that of the sclerotic is rather abrupt and sudden, although the exact point may not be everywhere easy to determine. The continuity of the two sets of fibres is complete, the main difference between them being that of transparency. The more orderly, clear, and homogeneous lamellæ of the cornea cease, and the more irregular, opaque, and fibrillated bundles of the sclerotic begin; but there is no break, as they pass into one another. The margin of the cornea, or *limbus corneæ*, is bevelled off, and is overlapped by the sloping edge of the sclerotic, so that the line of union is oblique or slanting. Occasionally the scleral tissue, besides spreading thus over the front, reaches a short distance over the posterior aspect also, and the periphery of the cornea is then wedged in between the inner and outer portions.

The border of *Descemet's membrane* is thin, and, along with some fibres of the adjacent substantia propria, joins thick and sometimes more opaque cords, which form a complicated network at the *angle of the anterior chamber*. This is the *ligamentum pectinatum iridis*, composed of successive sheets closely connected with one another, each consisting of a mesh-work of cords varying in thickness and running in all directions. These trabeculæ have epithelial cells adhering to their surface, and the roundish or somewhat oval nuclei of these are conspicuous in all preparations, while only here and there can some delicate cell-substance be distinguished about them. When Descemet's membrane is stripped off from the cornea—and this can only be done with difficulty—the inner portion of the ligamentum comes away with it, and the two structures are seen to be directly continuous. In such specimens there is seen a band of fine annular fibres immediately outside the edge of the membrane. In sections are seen the other attachments of the ligamentum to the sclerotic, the ciliary muscle, and the iris. As regards the first of these, the outermost cords pass backwards, and are lost sight of among the annular scleral bundles which occur at this place, and some of them are apparently connected by means of fibrous tissue with the external layers of the ciliary muscle, as the latter arise among these bundles. As regards the second attachment, the cords pass backwards and inwards, and give origin to fibres of the ciliary muscle, between which they penetrate shortly. The bulk of the ligamentum terminates in this way. The cords of the third or innermost group, after passing backwards and inwards, curve still more inwards and even somewhat forwards, and give attachment to the root of the iris, with the stroma of which they are intimately connected. The form of the ligamentum varies exceedingly in different eyes; in one it is large with wide spaces and a most intricate arrangement, in another it is so insignificant that it can be defined only with difficulty. Frequently the layers lie close together, and the region is opaque; at other times they are wide apart and very clear; but usually the thick fenestrated membranes are in a series of plates which, owing to sections of their irregularities and cords, have little knobs and swellings in their course. The channels between the trabeculæ are the *spaces of Fontana*, which intervene between the aqueous chamber and Schlemm's canal.

The *canal of Schlemm* generally appears in sections as an elongated opening of irregular shape in the inner aspect of the sclerotic, outside the ligamentum pectinatum. It may be subdivided, and sometimes shows a lining of nucleated cells. The canal is situated further back, that is to say, nearer the equator of the eyeball, than the anterior edge of the limbus conjunctivæ. Still further back, as a rule, and therefore well removed from the conjunctival margin, springs the root of the iris.

The annular arrangement of the scleral bundles behind, and sometimes outside, the canal of Schlemm has been already noted. In the eyes of children the part of the sclerotic next the cornea bends inwards, where the curves of the two membranes meet. The inner part about Schlemm's canal, and especially the annular portion behind that space, projects internally, and there may be a corresponding depression on the outside, or the latter may be wanting owing to the greater thickness of the tunics here in the child. In adults this projection is only slightly marked, or is entirely absent.

Sections of a considerable number of *blood-vessels* occur in preparations of the corneo-scleral junction. They are branches of the anterior ciliary and the conjunctival vessels, which terminate in a series of loops in the conjunctiva, offshoots from which penetrate the sclerotic, and are connected with the vessels in the ciliary body, while some capillaries are found in the adjacent corneal tissue.

Ciliary Body.—The corpus ciliare is an annular band, lining the anterior portion of the inner surface of the sclerotic, extending in breadth from the iris to the choroid. As it is thickest in front, and the inner surface slopes backwards and outwards to the level of the choroid, meridianal sections are somewhat prismatic in shape, the base of the prism being directed forwards, and the tapering narrow edge towards the fundus, while the inner anterior angle is rounded off. It is divided into an anterior part, carrying the prominent ciliary processes, and a posterior smoother and thinner part; the former is the *pars plicata* and the latter the *pars non-plicata.* Its front border is continuous with the root of the iris and the ligamentum pectinatum; the hinder border joins the choroid at the situation of the ora serrata of the retina. Outside the ciliary body there are continuations of the lamina supra-choroidea and lamina fusca with the intervening lymphatic space; and, as it is therefore only loosely connected with the sclerotic, it generally falls away from the latter in the course of preparing specimens, remaining attached, however, in the neighbourhood of the ligamentum pectinatum.

The *stroma* agrees with that of the iris, and is composed of connective tissue with many corpuscles, which are either round and of various sizes, or branched and irregular, pigmented or non-pigmented. In the case of fair persons, almost no pigment is present; in those with dark hair, a few cells with a pale, diffused, brown colour are usually seen; but in preparations from the eye of the negro there is an abundance of branched corpuscles, filled with very dark particles.

Embedded in some of the stroma, and constituting the greater part of the ciliary body, lies the *ciliary* *muscle*, a ring of the smooth or unstriped kind of muscular fibres. Between its fasciculi the fibres and corpuscles of the matrix may be seen, especially the dark cells of a richly pigmented eye. Anteriorly it arises from the sclerotic and the ligamentum pectinatum; and the external fibres can be traced among the annular scleral bundles behind Schlemm's canal; while those further in start from the trabeculæ of the ligamentum. The fasciculi have mostly a meridianal direction; and the external layers spread backwards from their origin; then they divide into diverging bundles, which unite with one another and may form knots, and again divide, ultimately ending partly in brush-like processes, which are lost to view in the outer strata of the choroid, a few fibres sometimes seemingly adhering to the sclerotic. The middle or "radial" bundles course backwards and inwards; but at the same time diverge to the sides from their anterior attachment, and thus cross, and unite with, each other. This divergence increases further inwards, until the most central and anterior bundles have a circular path. In antero-posterior sections the layers of radiating bundles are seen to unite at many points, and they thus form a network with elongated spaces, the outer laminæ extending over a greater distance from before backwards than the inner ones. An expansion, covering the whole internal surface, may be distinguished, composed of annular bundles, which are continuous with the adjacent bands. The anterior and internal circular portion of the muscle has been described as a separate muscle, the compressor lentis of Müller. Owing to this arrangement of the various parts, meridianal sections show the outer or longitudinal bundles cut length-ways, the middle or radial cut obliquely, and the inner or annular cut transversely; while in transverse or equatorial sections, on the other hand, the external fibres are cut across, the middle obliquely, and some internal ones longitudinally. In such preparations the different sets gradually merge into one another, and are not clearly separated; they are all firmly united to the surrounding stroma. Iwanoff thought that the circular bundles generally were relatively largely developed, and projected forwards, in the short eyeball of hypermetropia, while the meridianal bundles preponderated, and the anterior boundary of the muscle sloped backwards and inwards, in the long myopic eye; but he found that this rule did not always hold good. There is a relation between the form of the ligamentum pectinatum and the variations in the ciliary muscle; if the ligamentum terminate to a large extent in the sclerotic, the external or meridianal fibres of the muscle, arising from this locality, are proportionally numerous; whereas, if the ligamentum be more loose and spreading in its arrangement, many of its cords pass directly to the muscle, and the quantity of annular fibres is greater. This may be stated in another way: the annular portion is increased with a wide, and diminished with a small, angle of the anterior chamber, which coincides with the fact that in the hypermetropic eye the narrower ciliary muscle is relatively further forwards than the broader one found in the eyeball usually accompanying myopia. The size of the ciliary muscle does not seem less in the child than in the adult.

A layer of stroma, free from muscular fibres and forming a prolongation of the similar tissue of the iris, covers the internal aspect of the ciliary muscle; and extensions of it form the main substance of the ciliary processes. *Blood-vessels* are abundant in the ciliary body, but especially so in this inner region; and a common object in the anterior part of the ciliary body is a transverse section of the vessels composing the circulus anteriosus iridis major, from which branches pass into the iris. Many *nerves* are distributed throughout the whole body, more particularly in its outer part, and among them there are *ganglionic cells* in little collections or isolated.

The layer of stroma is bounded by a clear homogeneous membrane, which is a continuation of the *lamina vitrea choroideæ*, passing over the ciliary processes, but not so well defined there as between them. When viewed from within, its surface is seen to be uneven. Next the ora serrata it is pretty smooth, some slightly raised lines being visible, enclosing vaguely marked areas; further forwards there are well-defined elevations surrounding small irregular depressions; about the posterior part of the pars plicata, among the lower ciliary processes, these raised ridges become prominent, and the intervals are larger; between the higher ciliary processes the lines are pronounced, and enclose comparatively deep hollows of many kinds, large and small, round or polygonal. Everywhere the deeper parts are irregular in outline, and vary in size, while in some of the spaces masses of pigment remain after brushing the specimen. This configuration gives the surface a worm-eaten or eroded appearance. In vertical sections the walls of the pits appear as short rods projecting inwards, and the intervals between them are occupied by black prominences of the pigment layer, the arrangement being better or only seen when the latter has become slightly detached from the lamina vitrea in preparing the specimen, and the billowy outline of the pigment is separated from the clear membrane. It is sometimes impossible to distinguish the glassy lamina on the surface of the ciliary processes in sections, or it may appear as an extremely delicate line.

The *pigment layer* comes immediately inside the lamina vitrea, and is composed of roundish cells filled with dark-brown particles, amongst which the nuclei are rarely visible. As a rule, individual cells cannot be observed, and the layer forms a dense black mass, which in sections is a broad band, continuous in front with the uvea of the iris, and behind with the pigmented epithelium on the inner surface of the choroid. The posterior portion is the thickest, and the crests of the ciliary processes have often a considerably thinner layer over them.

Ciliary Processes.—The pars plicata or anterior region of the ciliary body owes its name to the presence of a series of meridianal folds or ridges, running from before backwards, and projecting inwards and forwards. These are the ciliary processes, and consist of extensions of the stroma, covered by the lamina vitrea, the pigment layer, and the pars ciliaris retinæ. Posteriorly they begin as slight elevations; but gradually increase in prominence, until anteriorly their height is considerable; near the iris they rapidly diminish, and mostly cease. On examining the inner surface of the corpus ciliare with a low power, it is found that the posterior zone, the pars non-plicata, is comparatively smooth, then in front of this there is a zone with more or less parallel ridges passing across it, then a zone of small secondary processes, and lastly the anterior zone bearing the prominent or primary folds, with intervening smaller or secondary ones. The ridges run forwards and stop between the hinder ends of the prominent folds, or they sink into the general level again, terminating either suddenly or gradually, or they divide and unite with the neighbouring secondary processes at this part. The posterior extremities of the primary processes rise steeply or slopingly, or have a free tail projecting backwards and ending in a blunt point. They have bulgings and swellings at the sides and on the surface, and are somewhat wavy in their course. In front their terminations cease abruptly, or project forwards and hide the root of the iris, or are continued on to the posterior surface of the latter. Between the adjacent primary processes, and quite independent of them and of each other, there are lower and shorter ridges; and, if more than one occupies the furrow, as is usually the case, two or three may rise from the bottom of the main groove.

Transverse sections afford further information. The processes may be sub-divided or compound, having two or three crests; and their outline is very irregular, owing partly to lateral undulations or bendings from side to side in their course forwards, but arising chiefly from twistings, with hollows and projections in the sides at different levels. Where they attain their greatest height, they show great diversity of form;

starting from the base in one direction, they change to another, then shift to a third, and so on, till the summit is reached, the outline being complicated by thickenings and excavations at the sides and by sub-divisions with similar characters. Thus, while one side of a process may continue to run in one direction, there may be a bulging on the opposite side at this level, giving the outline there a totally different course; or one spot may be hollowed out quite irrespective of any such mark on the other side. The distances between the folds are short and pretty regular; and in some of them lie secondary processes. The front of the ciliary body behind the root of the iris has a number of depressions or indentations, some of which are of considerable depth, while others are more shallow. They extend backwards in the anterior aspect of the thick portion of the ciliary body, behind the point at which the sides of adjacent ciliary processes sometimes unite with one another. A series of transverse sections at intervals from before backwards illustrates these facts very well. In such a section in front of the ciliary body, near the root of the iris, low rounded projections on the posterior surface indicate prolongations forwards of the ciliary processes. A little nearer the ciliary body long processes are attached to the iris, and these are the most anterior projections of the high folds. Behind this, where the ciliary body begins, a thin band of stroma unites the bases of long sub-divided processes. Slightly behind this the processes are shorter, and between them lie secondary ones, while, outside the band joining their bases and in the main mass of the ciliary body, there are openings edged with black, which are the mouths of the depressions just mentioned. A short distance further back the folds are smaller still, and in the thick band of the ciliary body, which passes across their bases, there are irregular openings lined with pigment, which are portions of the depressions. Still further back the processes are lower and simpler, and the openings have given place to black masses of pigment, corresponding with the floor of the depressions. After this the folds continue to decrease in height and size, and the thickness of the ciliary body to diminish steadily, until the pars non-plicata is reached, where the pigmented outline is nearly straight and the whole body comparatively thin.

Meridianal sections show, as might be expected, an equally great variety of outline. If taken from a part between two folds, there is little or no projection; if the whole height of a process is included, there is a large projection directed inwards and forwards; if the section is from a place where a process is continued on to the iris, and if almost all the rest of the fold has been cut off, there is a mass left adhering to the iris and hardly connected with the ciliary body. The base of a process may be cut off, and leave the crest attached to the iris and coursing freely backwards, or a similar fragment of a fold may be left united posteriorly to the ciliary body and passing forwards. The middle of a fold may be shaved off, and present an opening irregular in form and edged with black; or in a similar locality a mass of pigment may represent the deepest part of a lateral depression, the more prominent parts of which have been sliced off. In the same way the excavations about the front of the ciliary body may be indicated by spaces or by lines of pigment running backwards, according as their centres or their walls are present.

Pars Ciliaris Retinæ.—The periphery of the retina terminates at the ora serrata, where the choroid also ceases; but from that region there is a single layer of granular cells, which extends forwards over the ciliary body, until the periphery or root of the iris is reached, when it stops suddenly. This is called the pars ciliaris retinæ. Its elements are often badly preserved in hardened eyeballs; but in favourable circumstances various points can be determined. Near the ora the cells are elongated or columnar, and contain a long oval nucleus; and in this posterior region they appear somewhat curved, their inner extremities having points directed forwards and mingling intimately with one another. More anteriorly the cells become shorter and more flattened; and on the pars plicata they are nearly cubical, and have a round or slightly oval nucleus. Here they are covered with a delicate membrane, which gives the internal surface of the layer a sharp boundary in sections, especially at the sides and summits of the ciliary processes. At places in this front area, however, they may be more elongated. The cells sometimes contain particles of pigment, and possess short processes. Their union with the pigment layer is obscured by some of the dark granules, which are always scattered over this line in sections; but in some pathological conditions there is an indication of the presence of something like a basement membrane. Bright straight fibres of the *zonula of Zinn* usually adhere to their internal surface.

II. Pathological Conditions.

Cyclitis.—The ciliary region is regarded as "dangerous," owing to the untoward results which follow the infliction of an injury upon it or the lodging of a foreign body inside the globe in its proximity. A considerable proportion of the eyeballs, which are enucleated to protect the safety of the other eye, are affected with cyclitis or inflammation of the ciliary body; but the disease is then rarely, if ever, confined to this spot, inflammatory products occurring also in the iris, or in the choroid, or in both; and these cases are therefore classed clinically as irido-cyclitis, cyclo-iritis, irido-choroiditis, irido-cyclo-choroiditis, and so on. In the majority of such eyes, submitted to microscopical examination, there is inflammatory material about the ciliary region with organization into fibro-cellular membranes; but the chief character in some instances is an effusion of albuminous fluid, which coagulates on hardening, while in others the main changes are suppurative. Histologically, therefore, the varieties tend to overlap.

Inflammatory Œdema of the Ciliary Body.—In addition to hyperæmic vessels and a few round cells near them, there is an exudation in the enlarged ciliary body, which has rendered it spongy, separating even the muscular bundles from one another. In sections the meshes of the loosened tissue are empty, or filled with a transparent slightly granular substance, the margins of which usually show vacuoles; and there are also large granular cells, mostly rounded, but sometimes with processes, having one nucleus or two nuclei, and occasionally a few particles of pigment, or showing vacuoles or a clear envelope. The posterior chamber may contain a mass of similar serous exudation, which passes behind the lens and into the vitreous; and, if the edge of the pupil is fixed by synechia posterior, the iris is bulged forwards. Inflammatory round cells are usually seen in the exudation and in the pars ciliaris retinæ, the posterior part of the latter frequently exhibiting small spaces among its elements. Strings of fibrine appear here and there in the exudation. These conditions, if of long standing, are accompanied by changes and wasting of the pars ciliaris retinæ, of the pigment layer, and of the muscular bundles.

Purulent Cyclitis.—The local alterations consist of a profuse collection of round cells in the swollen ciliary body and the presence of pus on its inner surface, in the posterior chamber, and in the adjacent vitreous, mixed with strings of coagulated fibrine. In the earlier stages the round cells are situated in the layer of stroma internal to the ciliary muscle and in the pars ciliaris retinæ; but subsequently, though they may form more densely packed masses in the inner part, they are distributed throughout the whole ciliary body, in which there are also fibrinous exudation, remains of pigmented corpuscles, and vessels distended with blood-clot. At that stage there are signs of purulent iritis and choroiditis, with little colonies of round cells in the corneo-scleral junction and limbus conjunctivæ; it is then part of panophthalmitis.

Plastic Cyclitis.—This is characterized by its tendency to result in the formation of membranes. Various quantities of round cells are present in the ciliary body, especially in the inner layer near the hyperæmic blood-vessels; and an exudation of fibrine and round cells lies on the inner aspect, either among the cells of the pars ciliaris retinæ or outside a detached portion of them, or among the fibres of the zonula. It may have spread into the posterior chamber or across the eyeball behind the lens in the vitreous. Patches of the ciliary body are occupied by additional elements; and these may be accumulations of blood corpuscles, or the results of the degeneration of such extravasations, as reddish-brown molecular débris, or pigmented cells in the form of large rounded vesicles, containing brownish granules of considerable or small size, amongst which a nucleus is occasionally distinguishable. This corresponds with the pigmentation of leucocytes and connective-tissue corpuscles by absorption, shrivelling, and disintegration of red blood corpuscles, described as occurring in the neighbourhood of hæmorrhages elsewhere. Other patches, particularly in the outer and posterior part of the ciliary body, often show coagulated serum, with its clear or granular amorphous appearance and vacuolated border. At other places there is a deposit of fibrine in strings of various thicknesses, forming the usual branching network, or in beaded irregular rods, or in knobs, or clear vesicles, which may be minute with thin walls or larger with thicker walls. There aro often compound granular corpuscles, large granular cells with one or two nuclei and perhaps some brown particles, cells surrounded by clear enveloping material, and small, delicate, transparent, empty, and collapsed vesicles. Inflammatory round cells are occasionally found in considerable numbers about Schlemm's canal. The pigment layer frequently appears greatly increased in thickness, or is broken up and partially destroyed, the cells and free particles being in the adjacent exudation.

At a later date the exudation is replaced by a *cyclitic membrane.* This occupies part of the vitreous chamber, and its extent ranges from a thin layer over the ciliary body to a mass occupying the greater part of the vitreous humour, and causing extensive changes around. In one case, for example, it covers the ciliary body, and includes the zonula; in another it is continued forwards, and unites with a membrane causing widely spread synechia posterior between the iris and the lens, or even obliteration of the posterior chamber and union of the iris with the ciliary body; in another it stretches across the eyeball behind the lens; in another the lens is gone, and a mass of the new tissue occupies its place, and adheres to the adjacent structures. As regards the constituents of the membrane, very varied elements are found in different cases and at different parts of the same case, according to the severity, the complications, and the stage of the original inflammation. The basis is delicate connective tissue with interlacing bands; and among this are spindle cells, large round cells, leucocytes in larger or smaller groups or scattered, irregular corpuscles, pigmented corpuscles, blood-vessels, brown or black masses of pigment, granular detritus, fibrine, and areas with fatty degeneration, calcareous deposit, or formation of bone. Hæmorrhages are common; and these are partially organized, some portion of them being invaded by round cells or replaced by fibrous tissue, or their remains are seen as granular groups of colouring matter from the blood. The effects of the new formation present some features peculiar to each case; but among the most usual conditions may be mentioned the following. The ciliary body is atrophied; or contraction of the membrane, which is firmly united to its inner surface, has caused detachment, and the ciliary muscle is then dragged away from the sclerotic, especially at the posterior part, remaining attached about the ligamentum pectinatum, and curving thence inwards towards the centre of the eyeball, while the space outside of it is empty, or filled with blood-clot, serum, fibrine, or a more cellular inflammatory exudation. The ciliary processes are much distorted, thickened, thinned, or broken up. The whole ciliary region may be drawn towards the centre of the eyeball, and the opposite sides of the ring thus approximated; or traction may have caused the corneo-scleral junction to bend inwards locally. The anterior part of the choroid is detached along with the detached ciliary body, and the interval between it and the sclerotic contains some form of exudation. The lens and iris are sometimes pushed forwards; and the lens is degenerated, calcareous, or greatly distorted in shape; or, if it has been wounded, all that is left is the capsule curled up in the membrane. If the retina is detached —and this is of very frequent occurrence—its remains are folded up at the border or in the midst of the membrane; and the different layers often retain their characters and relations to a large extent; but at other times the whole thickness of the retina is composed of a loosely arranged tissue with fibres and abundant nuclei, or it is so much destroyed that only here and there can its characteristic elements be clearly distinguished. Portions of hyaline excrescences of the lamina vitrea choroideæ are not unfrequently found separated, and embedded in the cyclitic membrane among such altered traces of the retina, forming glassy bodies with irregular outlines and made up of several spheres with concentric lines. The optic disc may be atrophied or excavated. In an extreme case, the whole globe is atrophied and shrunken.

Ciliary Wound.—If the eyeball has been enucleated at an early date after the injury, a wound of the ciliary region is filled with an accumulation of fibrine and round cells; if later on, it is occupied by more or less organized material; if at a still later period, there is only cicatricial tissue. In addition there are the evidences of cyclitis in its various forms and with its manifold variations and results, for an injury here is generally the starting-point of marked inflammatory changes.

A foreign body lodging on the ciliary body, after penetrating some other part of the eyeball, is usually found surrounded by the products of plastic or purulent cyclitis, which may have been part of panophthalmitis or atrophy of the bulb, or may have been merely localized about the foreign body. If the substance is a fragment of iron or steel, it produces a rusty stain in the vicinity.

Atrophy of the Ciliary Body.—This is occasionally the result of cyclitis, and is also found in eyes which have for some time shown excessive intra-ocular tension. All the layers are affected, wasted, and thinned; but the pigment and the pars ciliaris retinæ suffer to a much less degree than the other structures. They may be the only parts left, and are then united to the sclerotic by a small amount of fibrous tissue. At other times the ciliary muscle has been observed with fatty degeneration or a deposit of calcareous matter. Clear transparent bodies with concentric lines, and surrounded by masses of pigment, corresponding with hyaline excrescences of the lamina vitrea choroideæ, sometimes occur; and in a few instances small portions of bone form in the ciliary body in stumps of eyes with chronic atrophy of the globe.

Atrophy of the ciliary body is present in advanced glaucoma. In old people the atrophy produces great reduction in thickness with transformation into dense fibrous tissue; but in young persons it is accompanied by stretching of the whole anterior portion of the eyeball, constituting buphthalmos, where the size of the globe is increased in all its diameters.

Ciliary Staphyloma.—This is a bulging outwards of part of the ciliary body and of the sclerotic external to it. These portions are thinned, atrophied, and generally adherent; the ciliary processes are displaced or distorted, and sometimes covered with membrane; while the ciliary muscle and vessels are wanting, when the atrophy has proceeded to a certain extent. Ultimately the ciliary body is represented by a thin layer, having on its internal surface some pigmented cells; or there may be nothing distinguishable but a line of pigment. The staphyloma shades off gradually into the normal condition at the margin of the protrusion.

Corneo-scleral Staphyloma.—In this affection the periphery of the iris is adherent to, and bulged outwards with, some part of the corneo-scleral junction, the local adhesion being either with or without an intervening delicate layer of clear and sometimes fibrillated material. The external tunics are more or less stretched and reduced in thickness; the ligamentum pectinatum and Descemet's membrane at the spot are altered or partially destroyed; and the spaces of Fontana and canal of Schlemm are obliterated locally. The iris looks in sections as if its root had been advanced, an interval occurring between the front of the ciliary body and the point at which the iris becomes free from the cornea, so that the origin of the iris no longer lies behind the edge of the limbus conjunctivæ, but considerably in front of it. At this interval is situated the staphylomatous protrusion of the corneal and scleral tissue, having on the inside the remains of the iris, the atrophy of which may be so extreme that only an irregular line of uveal pigment is left. In other instances the stroma of the iris at this part is much looser than normally, but more fibrous. Examples of this affection are found in sections of glaucomatous eyes, and the ciliary body is then generally united to the sclerotic and atrophied also.

Ciliary Region in Glaucoma.—When the intraocular tension is increased so that the eyeball feels hard, and the condition called glaucoma is established, sections from eyes removed in the advanced stage reveal changes at the ciliary region. The normal angle of the anterior chamber is obliterated by the contact of the periphery of the iris with, or its adhesion to, the periphery of the cornea. There is either simple apposition of the surfaces, nothing being seen between them, or the peripheral synechia is effected by means of a thin layer, which is transparent and sometimes shows longitudinal striæ. Fontana's spaces are thus obliterated, and Schlemm's canal cut off from its communication with the aqueous chamber, by the apparent advancement of the root of the iris. The antero-posterior extent as seen in sections, over which the parts are united, varies; but is usually considerable, and occasionally comparatively large. Locally there are commonly atrophic changes present, such as wasting of the iris and reduction of it to a thin membrane, more especially over the adherent area; and the ciliary body is also atrophied, the ciliary processes being then greatly shrunken or almost gone, and the mass of the ciliary muscle and stroma being compressed to a pigmented layer of little thickness inside the sclerotic, which may itself possess evidences of thinning. Weber has described compression of the circulus anteriosus iridis major, whereas, according to Brailey, the blood-vessels are dilated and thin-walled. Fuchs has noted them as normal, widened, narrowed, or invisible in different cases. They are almost destroyed in the atrophied ciliary body. A similar apposition of the periphery of the iris to the cornea has been seen in earlier stages, in which the ciliary processes were pressed forwards against the posterior surface of the iris, as if pushing it before them. The ciliary processes may be swollen, hyperæmic, and œdematous. The circular portion of the ciliary muscle, with the anterior part of the ciliary body, has been observed advanced in a like manner, and applied against the adherent portion of the iris.

The pupillary edge of the iris has some tendency to eversion forwards, and the uvea may be found continued round this margin and on to the anterior surface for a short distance. The sphincter pupillæ may bend round the pupil like the uvea, or in a late stage may not be distinguishable.

In a few cases, instead of the peripheral adhesion of the iris and cornea, the angle of the anterior chamber is occluded by a formation of fibrous tissue, or the ligamentum is transformed, apparently by pressure, into a solid-looking mass of dense finely fibrillated material, and the canal of Schlemm is no longer recognizable.

Leprosy of the Ciliary Region.—The researches of Bull and Hansen showed that little collections of leprous round-celled tissue may form nodules about the canal of Schlemm, and that from this point the disease extends into the corneal layers in front of Descemet's membrane, or into the iris. The spaces among the trabeculæ of the ligamentum pectinatum are packed with round cells, and the disease also spreads to the limbus conjunctivæ.

Tumours of the Ciliary Body:—

Sarcoma.—Sarcomata of the ciliary body have been described, both round-celled and spindle-celled, melanotic and non-pigmented.

Myoma.—A case of myoma, or myo-sarcoma, of the ciliary body has been recorded by Iwanoff.

Gumma and Tubercle.—A gumma in the ciliary body, like a tubercle in a cyclitic membrane, consists of a circumscribed accumulation of round cells (Weiss).

VITREOUS.

I. NORMAL STRUCTURE.

THE vitreous humour is a substance, very like egg-albumen, filling the space or chamber which is bounded by the retina, the pars ciliaris retinæ, the zonula of Zinn, and the lens. Under the microscope it is structureless and granular, and apt to have folds or creases. In this matrix, and chiefly in its outer portion, there are a few corpuscles with the characters of leucocytes, spheroidal, granular, and nucleated, now and then containing dark particles of pigment. Iwanoff asserts the presence of spindle-shaped and stellate cells, while, according to Schwalbe, the vacuoles which sometimes are found in the corpuscles are due to imbibition of fluid. A vague appearance of fibrillation is seen here and there, and about the ora serrata there are some fibres, which join the zonula ciliaris or suspensory ligament of the lens. This *zonula of Zinn* begins at the ora as delicate wavy fibrillæ, which pass forwards and are intimately united with the pars ciliaris retinæ; but it soon becomes composed of characteristic stiff, straight, smooth, transparent, glancing fibres, cemented together, which extend from the ciliary processes to the margin of the capsule of the lens; and bundles of these almost always adhere to the ciliary folds in sections of this region. A few leucocytes are entangled among them. A homogeneous hyaloid membrane, limiting the external surface of the vitreous, has been described, but the evidence in favour of its existence is not conclusive. The hyaloid canal is a channel, which passes forwards from the optic disc towards the posterior surface of the lens (Stilling).

II. PATHOLOGICAL CONDITIONS.

Hyalitis is the name given to the condition in which inflammatory products are present in the vitreous, and, as this humour is apparently entirely passive in the process, merely suffering invasion, the affection is always secondary to inflammation of the surrounding membranes.

Plastic Hyalitis.—This is found most frequently along with cyclitis or after wounds involving the vitreous, and its histology therefore corresponds so far with that of cyclitis or cyclo-choroiditis. Thus some part of the chamber behind the lens contains inflammatory exudation, or there are bands of wavy fibres, among which lie blood-vessels and groups of round, spindle-shaped, and other corpuscles of various forms and sizes, sometimes branched and occasionally pigmented, or collections of blood corpuscles with partial degeneration or organization, or molecular and fatty débris, or formations of bone. An extensive hæmorrhage into the vitreous with hyalitis may result in almost complete disappearance of the blood-clot, only a little granular detritus being afterwards found, or in a new fibro-cellular formation. A membranous growth may have its origin in the optic disc, which is diseased or excavated, or may be situated in the neighbourhood of the disc with retinitis. A shrunken vitreous is often enclosed by the detached retina in the form of a funnel, the wide base of which is attached about the ora serrata, while the apex is fixed at the disc. In the absence of the lens, as, for example, where a penetrating wound of the cornea and lens has led to the destruction of the latter, synechia or adhesion between a newly formed inflammatory tissue and the cornea or the iris may be found, the corneal cicatrix being continuous with the similar fibrous structure in the vitreous.

Purulent Hyalitis.—This is an effect of suppuration of the choroid or the ciliary body, and of panophthalmitis, or it follows a wound of the vitreous. The vitreous is largely infiltrated with, or even completely replaced by, an accumulation of pus cells, among which there are areas with degeneration and fatty granules. The process may have culminated in perforation of the outer tunics of the globe and subsequent cicatrization and contraction; or it may have become chronic, and the eyeball come to examination, when the altered vitreous is partially replaced by fibrous tissue, containing a variety of cells, such as branched and spindle-shaped corpuscles, or roundish cells with two or more nuclei.

Soft Vitreous or Synchisis.—This is a senile change, or it accompanies chronic disease of the uveal tract; and in the midst of the more than normally fluid humour there may be discovered minute collections of cells, or fragments and films of fibrous tissue, or granular or pigmented material. In *synchisis scintillans* plates of cholesterine occur, and also acicular crystals of tyrosin and granular globular masses of phosphates (Poncet).

The Cysticercus Cellulosæ, or scolex of the tænia solium, has been observed several times in the vitreous as well as in the aqueous chamber; and microscopical examination showed the ordinary structure of the parasite, with its vesicle and neck surmounted by a head, furnished with four lateral discs or suckers and a ring of hooklets.

OPTIC NERVE.

I. Normal Structure.

The optic nerve has two enveloping tubular sheaths, separated from one another by the inter-vaginal space; and from the inner one a supporting framework, accompanied in its ramifications by numerous blood-vessels, extends throughout the nerve itself. These protecting and supporting tissues are composed of white and some elastic fibres, in the midst of which abundant elongated, oval, and spindle-shaped nuclei are seen in stained specimens mounted in dammar. The trabeculæ are often separated from the enclosed nervous bundles by a small interval, on the surface of which oval nuclei of cells can sometimes be distinguished.

The *nerve fibres* are medullated, having an axis cylinder surrounded by a tube of the white substance of Schwann. They are said, however, to possess no primitive sheath, or sheath of Schwann, outside of this (Schwalbe). In unstained sections of hardened nerves mounted in glycerine they are very opaque, owing to the presence of the fatty matter of the medullary sheath, and the bundles are bound together by the much more transparent fibrous framework. In stained specimens mounted in dammar, on the contrary, the trabeculæ, which take on the dye, while the fatty matter remains nearly unaffected, are deeply tinted, and enclose the clearer nervous elements. In longitudinal sections almost nothing can be made out of the characters of the individual fibres; but transverse sections show that they are of various thicknesses, and the coloured axis cylinders appear as dots. They are united or cemented together by the *neuroglia*, a ground-substance with fine fibres and nucleated corpuscles, which is very granular in preparations. Its nuclei stain readily, and it frequently contains clear bodies of some size. The *inner sheath*, which is continuous with the pia mater, is closely applied to the nerve, and is comparatively thin. Outside of it, and between it and the thicker dense *outer sheath*, which is continuous with the arachnoid and dura mater, occurs the *inter-vaginal* (sub-arachnoid) space, an interval lined with epithelioid cells and crossed by a loose network of fibres covered with similar cells. These fibres are in branching and re-uniting fasciculi, and vary in amount from a few scattered cords to a considerable quantity, which resemble minute tendons, the cut ends of which are often curled up.

In transverse sections the supporting septa or *trabeculæ* form continuations of the inner sheath, passing inwards and dividing the nerve into irregular areas of different shapes and dimensions; in longitudinal sections a much more regular arrangement of the same framework is seen, with long cords running lengthways and giving off transverse or oblique connecting strands.

The *arteria centralis retinæ* with its vein passes in from the side at a short distance behind the eyeball, and then proceeds forwards in the centre of the nerve, accompanied by a sheath of connective tissue. The whole nerve is richly supplied with small vessels and capillaries.

According to the observations of Schwalbe, Axel Key, and Retzius, there is an elaborate series of *lymphatic spaces* throughout and around the nerve. Thus, inside the inner or pial sheath a space can be injected, continuous with spaces inside the trabeculæ, and between the trabeculæ and the bundles of nerve fibres, and between the nerve fibres themselves. Then, besides the inter-vaginal, there is a sub-dural space, lined with endothelial cells, between the arachnoid and dura mater, but not seen in health; and in addition there is a supra-vaginal space outside the outer sheath, forming a continuation of the cavity enclosed by Tenon's capsule surrounding the sclerotic.

II. Pathological Conditions.

Neuritis.—Under this heading, inflammation of the extra-ocular portion only of the optic nerve and its sheaths is here considered, although clinically the name is applied to papillitis or inflammation of the optic disc, the anterior extremity of the nerve, where it passes into the retina, that part alone being visible during life. Pathologically the diseases are distinct, and may occur quite independently of one another.

It is an interstitial inflammation, and is denoted by the presence of round cells in the connective tissue; sections show the leucocytes surrounding the blood-vessels, distributed in the course of the septa, or, in a severe case, diffused through the whole affected extent of the nerve. In stained sections mounted in dammar the abnormally numerous roundish nuclei are prominent and conspicuous. If the sheath is involved in the round-celled infiltration, this constitutes *vaginitis;* and the inner sheath is more frequently attacked than the outer. The inflammation may be accompanied by perineuritis, or by distension of the inter-vaginal space by serous fluid ; and different forms of *perineuritis* have been found, in which in the interval between the sheaths there was an inflammatory exudation of fibrine and round cells or of pus. In the former or plastic variety some formation of organized fibrous tissue may occur, and the space be partly obliterated. Interstitial neuritis tends to the production of such tissue in the stem of the nerve itself, with consequent atrophy.

Medullary Neuritis has been described, in which there were granular and fatty cells, with softening and degeneration of the nerve fibres, forming a gelatinous mass, with amyloid bodies (Türck).

Atrophy of the Optic Nerve.—This condition follows interstitial inflammation, and another cause of it is pressure on the nerve, as, for example, by an orbital tumour. Owing to the increase of fibrous tissue, the trabeculæ are thickened and closer together, while the nerve fibres are either simply reduced in number or size, or are much broken up, atrophied, and more or less destroyed. The diameter of the nerve is ultimately greatly diminished. The atrophy may be limited to some zone or sector, and is most common towards the circumference ; or it may be diffused, and the nerve be replaced by a comparatively thin fibrous cord, with granular and fatty débris representing the remains of the nervous elements.

Grey Degeneration of the Optic Nerve.—Here the nerve is somewhat shrunken, grey, and rather gelatinous in appearance. In the degenerated portion, which stains more deeply than the rest, the arrangement of the bundles is so far preserved; but the fibres have lost their medullary sheath, and become granular, or their place is occupied by slender transparent fibrillæ and thickened trabeculæ. Fatty particles and compound granular corpuscles occur in the earlier stages; and bright, smooth, glancing, round or oval, amyloid bodies are frequently present at a later date (Leber).

Pigmentation of the Optic Nerve.—An accumulation of black pigment between the sheaths round an atrophied nerve, and also in the atrophied nerve and disc themselves, has been seen (Knapp).

Tumours of the Optic Nerve :—

Sarcoma.—The inter-vaginal space may contain, and be distended by, sarcomatous elements, forming an expansion of a sarcoma of the choroid, which has spread backwards along the sheaths. Intra-ocular sarcoma also attacks the stem of the nerve.

Glioma.—Glioma of the retina extends backwards in the first instance along the substance of the nerve itself (Leber).

Myxoma.—A myxoma or myxo-sarcoma of the optic nerve consists of a gelatinous basis, with connective-tissue fibres and cells, such as spheroidal and stellate corpuscles; and it may undergo cystic degeneration (Rothmund).

Neuroma.—Perls examined a tumour of the optic nerve, which was composed of grey and medullated nerve fibres along with nucleated cells, and was surrounded by the distended sheaths of the nerve.

OPTIC DISC.

I. NORMAL STRUCTURE.

IN studying the optic disc and the portion of the fundus with the entrance of the optic nerve into the eyeball, the most useful sections are those, which divide the nerve longitudinally, and show the adjacent parts of the retina, choroid, and sclerotic cut at right angles to their surfaces.

The *outer sheath* passes into, and blends with, the external two-thirds or so of the thickness of the sclerotic. The *inner sheath* in a similar way becomes directly continuous with the remaining internal third of the sclerotic, which often contains a considerable number of pigmented corpuscles here; and it also helps to form the lamina cribrosa, some strands passing between the bundles of nerve fibres. The *inter-vaginal space* generally extends further in than the outer scleral layers, and in myopic eyes its extremity may bend away from the nerve, and penetrate for a short distance between the portions of the sclerotic, with which the sheaths become incorporated. The inner third of the sclerotic, therefore, with which the pial sheath is united, grasps the nerve, and is applied to it more closely than the outer two-thirds, for the latter portion is separated from the nerve by the inter-vaginal space. In hypermetropic eyes, however, this space may terminate at the level of the outer surface of the eyeball, or even further back than that. The scleral opening is wider posteriorly than anteriorly, its most narrow part being immediately behind the choroid, from which point it widens out backwards; and across the front portion there is stretched the *lamina cribrosa*, which corresponds histologically with a sudden and great increase in the amount of the connective-tissue framework of the nerve, where the nerve fibres lose their white substance of Schwann. It appears in sections as a well-marked pretty thick layer, composed of numerous bands of fibrous tissue; and, as the bundles run frequently at right angles to one another in passing across the opening, some of them are seen cut longitudinally, while others are cut transversely, and form rows of dots. It is continuous with the inner scleral layers; and derives its fibres from these and the conjoined inner sheath, from the trabeculæ of the optic nerve, and sometimes to a small extent from the junction of the choroid and the sclerotic, where there are some circular fibres. It has usually a slight convexity directed backwards; but a few scattered fasciculi in the anterior part of the papilla, in front of the choroidal plane, have a curved course with the convexity directed forwards, as they pass inwards towards the centre from the choroido-scleral junction and outwards from the adventitia of the central vessels. Transverse sections of the optic nerve at the level of the lamina cribrosa show this as a denser plate of the trabeculæ, the bundles being thicker, closer together, and enclosing smaller spaces than further back.

The *nerve* becomes thinner, as it passes through the sclerotic; and, when the lamina cribrosa is reached, it suddenly diminishes in diameter, as the fibres lose their medullary sheaths, only the slender, more transparent, and easily stained axis cylinders passing in bundles forwards through the cribriform membrane, accompanied by a little clear material of the neuroglia. The boundary line between the part with and the part without the white substance of Schwann varies in form in different eyes. According to Alt, in high degrees of hypermetropia it is funnel-shaped, the apex of the funnel being directed backwards and situated in the centre of the nerve some distance behind the level of the posterior surface of the sclerotic, while the base or rim of the funnel is at the circumference of the nerve in a line with the outer scleral layers. In high degrees of myopia, on the other hand, the boundary line runs straight across, or bends somewhat towards the front, and is placed as far forwards as the inner surface of the choroid.

The opening in the choroid is in some cases smaller than that in the sclerotic, and in sections its edges approach nearer one another; but at other times it is larger than the scleral gap, the edges of which are then without an anterior choroidal covering. Portions of blood-vessels are frequently seen in this region, as the short posterior ciliary vessels traverse the sclerotic to join the choroid.

About the middle of the nerve lies the *arteria centralis retinæ* with its vein, embedded in connective tissue; and in fortunate preparations their branches, which usually reach the anterior surface of the disc, curve to the sides, and portions of them are seen in the nerve-fibre layer of the retina. Offshoots from the arteriæ ciliares posteriores breves may pass into the nerve at the lamina cribrosa from the vascular ring of Haller, which surrounds it at this part.

In front of the lamina cribrosa the nerve fibres along with some connective-tissue elements bend to the sides, in faintly distinguishable bundles, to form the inner or anterior portion of the retina. This is the *optic disc*, the *papilla nervi optici*, and its diameter corresponds with that of the terminal portion of the nerve. As all the nerve fibres of the retina are present at the disc, and as they gradually decrease in number towards the periphery, the thickest portion of this layer is next the disc, and in vertical sections this in some instances shows a slight prominence; but in other eyes there is no such perceptible elevation above the surrounding retina. There is generally a nearly central depression of very variable size; and, although this is commonly merely a shallow indentation, it may be of some depth, and constitute a "physiological cup" or hollow extending backwards. In such cases the outer layers of the retina, it may be noticed, do not reach the margin of the scleral opening; but form a curved or sloping edge, the anterior layers ceasing further from, and the posterior ones extending nearer to, the centre, while the individual layers similarly become thinner as they approach this point. In other eyes the border of the retina terminates much more abruptly, and the various layers are somewhat suddenly rounded off. Schwalbe observed that the side furthest from the macula lutea has a more sloping margin than that opposite to it.

II. Pathological Conditions.

Œdema of the Optic Disc.—An œdematous disc is swollen, and projects forwards as a rounded mass beyond the level of the retina, having generally a wide, shallow, central depression, where the blood-vessels enter, between the more prominent margins. It consists of the nerve-fibre layer, the strands and bundles of which are pushed asunder, so that the tissue is spongy, and even forms a loose network in some places, the little spaces being either empty or filled with a granular coagulum of serous fluid. The blood-vessels may be found distended with blood-clot, and the outer layers of the retina displaced from the edge of the disc by the greatly thickened nerve-fibre layer, which bulges outwards over the internal surface of the choroid round the opening in that membrane.

Papillitis or Optic Neuritis.—In this affection there is interstitial inflammation. The disc is œdematous and swollen, so that it projects forwards; and there is usually a central depression, although this exaggeration of the physiological cup is often wanting. The vessels are more or less surrounded with leucocytes, an accumulation of which may distend their sheath; and the nerve fibres have a looser arrangement than the normal one. They may appear swollen, and some may have fusiform thickenings in their course, filled with granules (Pagenstecher). Among them there is an infiltration of round cells, either localized at certain spots or more extensively diffused. A similar collection of inflammatory cells occurs about the lamina cribrosa, which may seem thickened; and the numerous nuclei are prominent objects in stained specimens mounted in dammar. The plane of the lamina cribrosa is sometimes altered; thus the fibres bulge decidedly backwards or only some of them take this direction, or the anterior layers are pushed forwards. Hæmorrhages occur; and the blood corpuscles lie about the vessels, or among the nerve fibres, or the remains of extravasations are present as collections of blood-pigment.

The retina is most frequently displaced from the edge of the scleral opening by the swelling of the nerve-fibre layer here, the outer portion of the greatly thickened and spongy tissue spreading over the surrounding choroid, and so carrying the external layers of the retina before it. The nuclear layers may seem thickened or be blended; and the retina in the immediate neighbourhood of the disc is somewhat detached, and looks as if lifted up from the choroid by the papilla, a small quantity of coagulated granular material occupying part of the space which intervenes between the membranes. The outer surface of the retina in this region has frequently a series of projections or folds, and in sections these prominences give it a wavy outline, some of the sub-retinal coagulum generally adhering between the undulations. The pigmented epithelium may be absent at the edge of the disc behind the swelling, which has overlapped the choroidal surface, and then there is a little accumulation of pigment at the margin of the displacement, while some pigmented cells and free particles of pigment occur between the external retinal folds and among the coagulated substance on the surface of the choroid.

When the retina also is inflamed, the condition is known as *neuro-retinitis*.

Atrophy of the Optic Disc.—In an atrophied disc, whether resulting from the interstitial inflammatory exudation of papillitis, or forming part of the effects of a more widespread though local affection like choroido-retinitis, or accompanying disease elsewhere either in the brain or spinal cord, cicatricial tissue has usurped the place of the nerve fibres. The disc has suffered from the formation and contraction of fibrous, with disappearance of nervous, tissue. When the atrophy is advanced and complete, the surface of the disc has a shallow excavation with a sloping floor, and the fibrillated fabric forms a rather thin layer in front of the lamina cribrosa of variable density, in which the blood-vessels, if seen, are found to be narrowed, with their walls thickened and their lumen diminished or obliterated. The excavation extends to the level of the cribriform membrane, and this may show increase in thickness and density; but its position remains normal. The area of the disc is sometimes lessened, or only part of it may be affected with atrophy and contraction, and occasionally the neighbouring choroid is wasted.

A former dislodgement of the retina from the edge of the disc by the swelling of the latter may be found represented in post-papillitic atrophy by a permanent displacement at this spot, by means of a mass of connective tissue in place of the swollen nerve-fibre layer (Pagenstecher).

In some shrunken eyes the diameter of the optic nerve at its entrance is reduced, although the nerve fibres appear normal or merely slightly less in quantity; in other instances, even where extensive and destructive changes have occurred in the globe, the nerve seems normal as far forwards as the posterior boundary of the lamina cribrosa; but throughout this membrane and in front of it there is wasting of the nervous elements and excess of fibrous tissue.

Chronic inflammatory products now and then are present on the anterior surface of the disc; and the adjacent portion of the vitreous becomes the seat of a connective-tissue formation, into which vessels extend, so that an atrophied disc may be occupied or covered by a small growth, which projects forwards into the vitreous chamber.

When there has been increased intra-ocular tension, there are, besides atrophy, other characteristic alterations in the disc, which are described under "Glaucoma."

Optic Disc in Glaucoma.—The changes found in the ciliary region in sections from cases, which have reached an advanced stage of glaucoma, have been already mentioned. The alterations found at the same time at the disc are marked and distinctive. The whole extent of the disc is hollowed out into a cup of variable size, depth, and shape; and this is called a glaucomatous excavation. It looks as if the surface of the disc had sunk backwards behind the level of the retina; and the lamina cribrosa, which may be thickened, or more dense than usual, or reduced to a thin layer, seems pushed backwards to a smaller or greater extent, even perhaps beyond the level of the posterior surface of the sclerotic.

There are sometimes inequalities in the depth of the excavation at different parts. The nerve-fibre layer is wasted and much thinned over the floor and sides of the depression. The walls of the hollow are, as a rule, undermined, the diameter at the mouth of the cup being somewhat less than at a short distance further back, and those nerve fibres which are left make a sharp bend, as they pass round this overhanging edge. If the blood-vessels happen to be present at this part of the section, they lie behind the projecting margin of the opening, and make a similar sudden bend round it. They are often seen situated in a slight prominence, of which they form the bulk, projecting from the general level of the walls or floor. In some instances, while the edge is conspicuously overhanging at one side of the disc, it is less so, or not at all so, at the other side, or the wall may descend as a steep slope to the floor of the excavation. The nerve fibres outside the lamina cribrosa are occasionally atrophied, as after interstitial neuritis, with thickening of the fibrous framework and the inner sheath; and delicate connective tissue sometimes covers the surface of the cup or part of it. There may be a second smaller cup in the floor of the main one; and this arises apparently from widening of the passage of the central vessels.

The choroid in the immediate neighbourhood may be quite normal, or contain a few extra round cells; but is usually atrophied, and the pigmented epithelium is wanting.

The retina about the disc may be œdematous, thickened, or somewhat thinned and atrophied; or it may show complete detachment, and proceed forwards from some part of the cup as a fibrous cord. The dragging forwards of the papilla by a detached retina may mask or prevent an excavation in glaucoma.

At the side of the disc a posterior staphyloma is sometimes present; and, when the glaucoma has been produced by an intra-ocular tumour, such as a sarcoma of the choroid, the excavation may be covered over, or filled up, by the growth pushing the detached retina before it.

In hæmorrhagic glaucoma minute miliary aneurisms of the small blood-vessels and capillaries of the retina with thin walls have been observed.

Connective-tissue Formation on the Optic Disc.—A rather uncommon condition of the disc occurs, in which there is a vascular connective-tissue growth, arising from the papilla or its neighbourhood and extending into the vitreous. A loose network of fibres encloses large spaces, and may have masses of dark pigment, or pigmented cells, or free brown particles throughout it. The course of the fibrous bundles is irregular, and the spaces are empty, or filled with finely granular material, collections of blood-vessels, or compact accumulations of blood corpuscles. The blood-vessels in such areas, which may form a considerable proportion of the growth, are thin-walled and very numerous. Small extravasations may be found, or the traces of former hæmorrhages as reddish-brown molecular masses, or pigmented nucleated cells, such as result from the absorption and degeneration of blood corpuscles in cells elsewhere. Many large, nucleated, granular, spheroidal corpuscles are scattered about, and also cells, which have undergone partial degeneration and destruction.

An amorphous substance with many molecules or fibres is arranged somewhat concentrically round some of the spaces, the successive layers being separated at intervals by fatty débris and cells of various shapes. The margins of such a growth may spread as a membrane beyond the disc, and either terminate in a free border overlapping the retina, or be attached to the inner surface of the latter here and there, and finally merge with that structure, which is in such cases diseased and degenerated.

RETINA.

I. NORMAL STRUCTURE.

THE retina consists of several layers, which are easily distinguished in a vertical section. These are, in order from within outwards, the membrana limitans interna, the nerve fibres, the ganglionic nerve cells, the internal molecular, internal nuclear, external molecular, and external nuclear layers, the membrana limitans externa, the rods and cones, and the pigmented epithelium. The fibres of Müller pass vertically between the two limiting membranes.

The nomenclature of the retina is very confusing, owing to the variety of names applied to several layers in different books; and a note of the most common of these may prove convenient:—

The membrana limitans interna is spoken of as the limitans.

The fibres of Müller are called the radial or radiating fibres.

The ganglionic nerve cells are called the ganglion cells or simply the nerve cells.

The rods and cones form the bacillary layer or Jacob's membrane.

The pigmented epithelium is known as the pigmentary layer, the hexagonal pigment, the hexagonal pigmented cells, or the hexagonal pigmented epithelium.

None of these terms can lead to doubt as to the tissue indicated; but with the intervening four layers great uncertainty is apt to arise; and, as the terms first given are apparently those most widely used, they are the ones employed here.

The internal or inner molecular is called the inner or internal granular, the finely granular, and the internal granulated layer.

The internal or inner nuclear is called the internal or inner granular, the inner nuclei, and the internal granule layer.

The external or outer molecular is called the inter-nuclear, the middle granular, the inter-granular, the outer or external granular, and the external granulated layer.

The external or outer nuclear is called the external or outer granular, the outer nuclei, and the external granule layer.

The pigmented epithelium has been already described in connection with the choroid.

The relations of the different elements are most satisfactorily studied in vertical sections; and considerable variations in their appearance, thickness, and relative proportions are met with in different regions and in different eyes. In specimens mounted in glycerine the structure is comparatively fibrous, owing to the abundant delicate fibrillæ coursing throughout it, mostly in a vertical direction; and the bright nuclei are conspicuous, appearing like clear round cells. In other specimens mounted in the same way, the ground-work is more granular, close inspection showing that this resembles a most minutely spongy tissue with exceedingly fine and intricate meandering septa, suggesting collections of particles where they are cut across. In the great majority of cases little or nothing can be made out of the nerve cells, and it is only in very fortunate instances indeed that their connections and processes can be traced for any distance. The rods and cones always show some *post-mortem* changes, even in sections where the other elements are beautifully preserved; they are softened and broken down, or confused together, or form a granular mass, in which only a vague indication of their former structure can be distinguished, or they are entirely absent. It seems, therefore, that little reliance can be placed upon elaborate descriptions of pathological alterations in this layer found in sections. In stained specimens mounted in dammar or Canada balsam, much of the fibrillated appearance of the retina is lost, most of the fibres seen being those of Müller. Here again the nuclear layers are prominent, for they take on the dye readily; the nuclei of corpuscles among the nerve fibres are also deeply stained, as well as those of the nerve cells. When double staining with magenta and iodine green is employed, the nuclei become green and the rest of the retina red.

The larger *blood-vessels*, which are branches of the central vessels seen at the disc, are found almost entirely among the nerve fibres, and capillaries are found here and also nearer the outer surface, but not beyond the external molecular layer. The vessels are surrounded by a peri-vascular lymphatic sheath, which, according to Schwalbe, can be injected from the lymphatics of the optic nerve.

The *fibres of Müller* are the most prominent parts of a *supporting matrix*, which pervades the retina. They run in a vertical direction between the inner and outer surfaces, and in sections, where the nerve fibres have been cut longitudinally, collections of the radial fibres form, at intervals, columns, which are clearly defined and fairly straight in this layer, with expanded bases spreading towards each other at the inner surface. In sections with the nerve fibres cut transversely, the fibres of Müller do not present such a regular arrangement, appearing rather as an irregular network between the nervous bundles. Although many of them are almost immediately lost sight of, some of them can be traced outwards, after passing between the nerve cells, in the internal molecular and internal nuclear layers, ceasing to be distinguishable in the external molecular or the external nuclear layer, while others can occasionally be observed penetrating through even this outer region to their termination in the *membrana limitans externa*. As a rule, owing to their delicacy and the intricacy of the tissue, it is not possible to demonstrate direct continuity of the individual fibres to any great length, though slender bundles can be followed longer. Their minuter details can be examined at cracks and breaks in sections, or where œdema has loosened the structure; and in such places it is seen that they give off fibrillæ and exquisitely fine lamellæ in their course, especially in the nuclear layers, which bind the various elements together. Near the inner conical base there is sometimes a nucleus, and a nucleus is connected with them as they penetrate the internal nuclear layer. Their inner extremities constitute the *membrana limitans interna*, which bounds the retina next the vitreous, and, when the surface of this is stained with silver, it shows a pattern of dark lines, recalling an epithelioid or endothelial layer of cells, the substance which cements the fibres together being darkened. The markings, which are due to the distribution of the ends of the radial fibres, are very irregular, and over the vessels the enclosed spaces are smaller than elsewhere, and in some parts are slightly elongated across the path of the vessel.

The *nerve fibres* are destitute of a medullary sheath, and this layer, which diminishes in thickness from the disc to the ora serrata or anterior margin of the retina, is a collection of thin fibres of different diameters, running parallel with the surface, and in their course sometimes exhibiting, under a high power, varicose thickenings, which are apparently artificial. Some separation into bundles is observed in sections in which they are cut across. They are the continuations of the axis cylinders of the optic-nerve fibres, mixed with neuroglia, of which connecting substance very little is seen except the nuclei of its corpuscles in stained preparations. Scattered round lymphoid cells occur in it, and in stained sections some branched fibres are found, which have taken a deeper colour than the others, and pursue a horizontal, an oblique, or a vertical path for a considerable distance, showing thicker and thinner portions.

The *ganglionic nerve cells* form a single layer of large and usually multipolar nucleated bodies of varying size and shape. They are generally very badly defined, and it is only in specially successful specimens that they can be recognized, their former situation being frequently empty or partially occupied by some débris, in which a nucleus is occasionally noticed. If well preserved, they are granular, and possess a large round nucleus with a nucleolus; and, while one pole or process seems to extend inwards among the nerve fibres, amongst which, however, it can be only very shortly traced, other poles pass outwards and branch. Mingled with the fibres of Müller, these can be occasionally followed over a greater or smaller area, and many such fibres, some of which may be nervous, pass outwards without being obviously connected with the ganglionic nerve cells. About the cells the tissue is often looser, with empty spaces, and, as this layer encroaches partly on the one outside of it, the boundary between them is uneven, and the cells seem partially embedded in the internal molecular layer.

The *internal molecular* layer is composed of exceedingly delicate and short fibrillæ matted together, and having the appearance of small molecules or particles in sections. It resembles a finely granular, amorphous, ground substance, or a spongy basis, with here and there a more definite arrangement of little threads distributed like a mesh-work. There are a few nuclei present, and through it some radial fibres pass, while others are lost in the maze.

The *internal nuclear* layer consists chiefly of transparent bodies of various shapes and sizes, which are mostly spherical, though some are oval, or appear even fusiform, from the presence of cell-substance enveloping them. After staining they are granular, and show nucleoli. Among them are seen fibres of Müller, to which some of them belong; but, for the most part, they are the nuclei of bipolar cells or elongated spindles, the processes of which extend between the two molecular layers. The nuclei here are larger than those of the external nuclear layer; but, as there are fewer of them, the band, which they form in sections, is not so broad. A cementing or supporting substance, connected with the radial fibres, permeates the layer.

The *external molecular* layer agrees in its composition with the internal one; but it is thinner, and its boundaries are better defined.

The *external nuclear* layer also corresponds so far with the internal one; but it is thicker, and the nuclei, though smaller, are more numerous and closely packed together, in some cases also staining more deeply. They often appear round, but some are oval, and, in other instances, they almost all seem fusiform from the substance of the fibre, in a swelling of which they are embedded, or only a few have this shape, while at the outer surface for a similar reason some are often found to be conical, the base of the cone resting on the membrana limitans externa. They belong mostly to vertical fibres, distally connected with the rods and cones; and the nuclei of the cone fibres are near the membrana limitans externa, those of the rod fibres, on the other hand, forming the inner strata. This layer occasionally in the fundus has a division into two parts, the outer one being studded with the nuclei as just described, and the inner one consisting of bundles of fine, wavy, vertical fibres, unobscured by the presence of nuclei, and forming pillars, starting from the external molecular layer, and losing themselves among the nuclei or being directly continuous with them. Some similar fibres are prolongations of the fibres of Müller, but such a connection is only exceptionally detected.

The rarity of finding the *rods and cones* in a state of good preservation in sections has been already mentioned, and few specimens are satisfactory; but occasionally somewhat rod-shaped or club-like bodies are visible, and even a division into outer and inner segments. The following points have, however, been ascertained by special methods of preparation, such as the use of osmic acid for hardening. They have each an outer and an inner segment: in the case of the rods, the outer one is cylindrical, and the inner one, which is of about the same length, but broader, bulges slightly in the middle; in the case of the cones, both segments are conical, and the more slender outer one is shorter than the outer segment of a rod. The external segments of the rods appear striated longitudinally on the surface, and a similar linear marking is present on the inner segments of both rods and cones. The outer segments of both kinds break up in fresh specimens into discs. Schultze asserts that the inner segments are directly connected with rod and cone fibres and nuclei respectively.

Macula Lutea.—The retina is thicker at this spot, and sometimes contains diffused yellowish pigment. In the centre there is a wide and deep depression on the anterior surface, the *fovea centralis.* The rods are almost entirely wanting (Henle), and the inner part of the external nuclear layer is therefore formed of the cone fibres, the path of which corresponds pretty much with the sloping walls of the fovea. The fibres of Müller have a similar course through the retina here. According to Schultze, there are several layers of bipolar ganglionic cells at the macula, and towards the fovea the rods disappear, leaving only cones, which are longer and thinner than elsewhere. The other layers become greatly reduced in thickness towards the centre of the hollow, until there are only cones, the membrana limitans externa, and the external nuclear layer, having anteriorly some fibres and nuclei representing the remaining retinal layers.

Ora Serrata.—Towards the notched and dentated anterior border or periphery of the retina, the ora serrata, the thickness of the individual layers, and therefore of the membrane as a whole, gradually diminishes. Then, just at the edge, the elements become merged in a fabric with fibres running in all directions, among which nuclei are scattered irregularly. This suddenly ceases, and is rounded off at the junction with the pars ciliaris retinæ.

II. Pathological Conditions.

Œdema of the Retina.—When a portion of the retina at the fundus is affected with œdema, its thickness is augmented ; and, in place of a compact arrangement, there is a loose tissue. As a rule, however, the alterations are not diffused through all the strata ; but are confined to, or most manifest in, the nuclear layers, in which there are relatively large spaces, empty in sections, and separated from one another by cords and columns of fibres and nuclei. When the external nuclear layer is involved, the inner fibrous portion of this seems to suffer chiefly, the normal intervals between the bundles being elongated and widened ; when only the internal nuclear layer has been attacked, large and long openings occur between oblique or more vertical rows of nuclei mingled with, and embedded in, collections of fibres. The layer is greatly expanded, and the elements, which look pushed aside or compressed, may be rather opaque, granular, and swollen, apparently from being soaked in the effused serous fluid. Modifications of these œdematous changes occur, and the appearances presented are then altered accordingly. Thus the spaces may be small and less confined to definite layers, or the whole thickness of the retina may be loosened and softened.

Cysts and Œdema at the Ora Serrata.—The condition of the periphery of the retina to which the name œdema has been applied is seemingly a senile change. Cavities, separated from one another by vertical septa, are found in the nuclear layers of the thickened membrane, or the external molecular layer is interrupted, and the same cavity extends through the two nuclear layers and this one. The alteration resembles a cystoid degeneration, accompanied by atrophy of the nervous, and increase of the connective, tissue elements.

Another variety of cystic formation is seen in spots especially at the anterior margin of the retina. In an almost completely atrophic and delicately fibrous feltwork numbers of spheroidal cavities with some larger spaces occur. The retina may be divided locally into two layers of nearly equal thickness by one of the comparatively large intervals, situated about the external molecular layer, as can be determined at the edge; and through this opening there pass pillars, composed of radial fibres, while in its walls among the fine fibres there are many small cystoid cavities, the boundaries of some of which project into the large aperture, while others bulge into the vitreous. Most of them are empty; but a few are filled with a clear amorphous or faintly granular mass. A few retinal nuclei may be left in the outer portions of the membrane.

Retinitis.—Several varieties of inflammation of the retina can be distinguished microscopically, if the main characters or tendencies be taken as a guide. A degenerative form finds a typical example in the albuminuric inflammation, the histological changes in which are not peculiar to retinitis accompanying Bright's disease, the name owing its origin to the clinical features and the ophthalmoscopic appearances; a plastic form tends to atrophy; and a suppurative kind leads to destruction.

Albuminuric Retinitis.—Retinitis albuminurica affects the fundus, especially about the macula, and, the disc being involved, is a neuro-retinitis.

So far as the papillitis is concerned, there is nothing requiring special description. The papilla is œdematous and swollen, almost always having some infiltration with inflammatory round cells, and appears in sections as a rounded prominence with the usual central depression. The surrounding retina is slightly detached and displaced from the edge of the choroidal opening by the swelling of the disc; and its outer surface may have wavy folds, while the tissue is distended with œdematous and inflammatory effusion, the rods and cones being partly destroyed or, it is said, considerably elongated. The affected portion of the retina may be similarly œdematous, and the somewhat expanded nerve-fibre layer, which projects inwards and also encroaches on the outer layers, may, near the disc, contain inflammatory round cells. The radial fibres, as they pass through this layer are swollen, and have a clear shining look, this condition being spoken of as "sclerosis." The nucleated cells here are more numerous than in ordinary circumstances, and compound granular corpuscles may be present. Some of the nerve fibres either have a more uniform thickening, or show a series of successive swellings (as if from imbibition of fluid) filled with granules or fatty globules, these fusiform dilatations giving them a varicose outline (Müller). The blood-vessels are sometimes surrounded by leucocytes, a condition which, when occurring alone in the retina, is known as peri-vasculitis or peri-arteritis. At other times their walls are thickened and their lumen diminished, like those in other organs in Bright's disease, presenting a hyaline, highly refractive appearance, to which the name sclerosis is applied. The capillaries are more conspicuous than usual, apparently from some similar thickening of their walls. Hæmorrhages are seen as collections of blood corpuscles both in the inner layers and as far outwards as the external molecular layer. The ganglionic nerve cells are mostly unaffected, apart from the ordinary *post-mortem* changes.

In the outer strata, the supporting connective tissue and the fibres of Müller are thicker than in the normal condition; and the two molecular and nuclear layers, either separately or together, have in sections a series of somewhat round or oval areas, separated from each other by bundles of vertical and sometimes rather granular fibres, the spaces containing more or less clear amorphous material or bodies resembling cells. The last are large, spherical, or irregular, and crammed with fatty granules, while some possess a distinct nucleus, and they often have a faint brown or yellowish tinge. Many of them are compound granular corpuscles. They may be pressed together, and form masses with uncertain limits; and between them there are clear spots like small drops of fat or vesicles of various sizes, suggesting vacuoles in a coagulated and hardened albuminous fluid. These granular and clear bodies seem to be the remains of inflammatory exudation, and some of the material is derived from degeneration of collections of blood corpuscles, an obvious indication of their previous structure being found at places where only partial degeneration has occurred. Compound granular corpuscles have been observed in the inner layers of the retina also.

The rods and cones are rarely present as such in sections, and their place is taken by granular sub-retinal exudation. The gangliform swelling of the nerve fibres may not be present, when the most noticeable features are the thickening of the connective tissue and the occurrence of the products of fatty degeneration.

Plastic Retinitis.—This is an interstitial inflammation, and is found in shrunken globes or eyeballs with phthisis bulbi, detached retina, retinal wounds, choroido-retinitis, staphyloma posterior where it is local, or glaucoma where it is near the disc. The process is confined to the inner layers at first; and the outer ones, except the rods and cones, may not be affected for a long time (Iwanoff).

In the acute stage the nerve-fibre layer is swollen and infiltrated with round cells, especially along the sides of the blood-vessels, constituting peri-vasculitis. At a later period the fibres of Müller are hypertrophied, and their ends may project into the vitreous from the growth of fibrous tissue, especially about the disc; and in a section of that region they sometimes form a series of arches, in which lie some remaining nerve fibres. In such cases the infiltration has been succeeded by a formation of cicatricial tissue, and the ensuing contraction, accompanied by destruction of the nervous elements, has resulted in the obliteration of the lumen of the vessels and conversion of them into fibrous cords. The nerve-fibre layer, and therefore the retina as a whole, is consequently thinned. The molecular strata disappear; and the nuclear layers unite, and are ultimately destroyed. It is said that the rods and cones at an early stage are elongated and club-shaped or pyriform; they are finally lost (Klebs). If any traces of them are present in sections, they are embedded in a granular mass; but the *post-mortem* changes occurring in this layer must not be forgotten.

The later changes are characteristic of atrophy; and, in a case where there has been conjoined inflammation of the choroid, the retina is pigmented.

Leukæmic Retinitis, or inflammation of the retina in patients with leukæmia, seems to be of an interstitial nature, and is characterized by the presence of little knots of white blood corpuscles in the retina (Leber).

Purulent Retinitis.—Suppuration of the retina is generally examined microscopically, as it occurs in eyes with purulent panophthalmitis. There is a profuse inflammatory infiltration in the thickened nerve-fibre layer; and the leucocytes are most abundant in the initial stage round the blood-vessels. At a later date, however, they are widely diffused, with destruction of the normal constituents, so that nothing but a crowd of round cells is to be seen. Ultimately the entire thickness of the retina is affected and destroyed in this way. Areas of hæmorrhage are present; and the pigmented epithelium usually appears increased and broken up.

Atrophy of the Retina.—In a retina which has undergone atrophy, as, for instance, after interstitial retinitis, the process, when complete, leaves a comparatively thin fibrous membrane with a few more or less obliterated vessels with thickened walls, or denser cords representing their former situation. In some localities a less thorough transformation is shown by the occurrence of scattered nuclear elements in the external portion of the thinned and wasted membrane, and the arrangement of the fibrous tissue in this outer part is rather that of a mesh-work, as compared with the more linear distribution of it in the inner strata. The membrana limitans interna is occasionally considerably thickened, and appears as a loose fibrous fabric.

Pigment derived from the epithelial cells or from hæmorrhages is frequently present, producing the condition known as pigmentation of the retina, which is always a sign of atrophy.

When the wasting is secondary to disease of the optic nerve, as in atrophy of the disc and glaucoma, only the inner layers, the nerve fibres and cells, are involved for a long time; and the outer strata may be almost or quite perfect after many years.

In glaucoma with hæmorrhage, Pagenstecher and Genth found obliteration and degeneration of vessels, varicose veins and capillaries, and accumulations of blood corpuscles dispersed throughout the atrophied retina, which was expanded by the extravasations.

Choroido-Retinitis and Pigmentation of the Retina.—The changes which are produced in the retina in connection with disease of the choroid and alterations in the pigmented epithelium have been alluded to in a former place; there remain to be considered the effects of inflammatory conditions occurring in the choroid and retina together, with atrophy and deposit of pigment. In addition to the atrophic results of choroiditis with disorder or destruction of the pigment and thinning of the choroid, that membrane is united to the altered retina either extensively or at circumscribed areas, and there is loss of the normal elements of the retina with substitution of fibrous tissue, in which pigment is embedded. The outer layers are first affected; but the whole thickness is found involved at a later period, and is composed of a loose net-work of bundles of fibres. The nerve fibre layer, in which there are conspicuous columns of Müller's fibres, seems to be the last and least affected, and is usually distinguishable, even when most of the other structures are wanting; but many of the longitudinal fibres here may in reality be cicatricial and not nervous. There is in some instances a covering of delicate connective tissue on its surface. Until an advanced stage, there are some nuclear elements disposed irregularly in the outer parts. The blood-vessels show thickening of their walls, with narrowing or obliteration of the lumen; or fibrous strings mark their former situation. The most striking character, however, is pigmentation, which is present only when there is atrophy. In any or all of the layers, and especially along the walls of the vessels, there are large black and brown masses, spheroidal pigmented cells, clusters of granules resembling cells, or free dark particles. This pigment is derived from, and possesses the characters of, that found in the choroid and the pigmented epithelium, with which, indeed, dark brownish bands are sometimes continuous.

Another kind of pigment, which occurs along with that just mentioned or apart from it, is of a hæmorrhagic nature, and comes from the colouring matter of the blood. Glancing bodies, which are reddish-brown in colour, mingled with brown or yellow granular débris, are distributed in the atrophied retinal layers.

Detached Retina.—The retina is found detached from the choroid by such materials as serous fluid, inflammatory effusion, or extravasation of blood, or displaced by a sarcoma of the choroid. In the first case the interval is partly or entirely occupied in sections by a clear amorphous mass, with granular areas and scalloped or nodulated margins; in the second case, leucocytes abound in the coagulated exudation; a subretinal clot is, of course, formed of blood corpuscles mainly; and, when a sarcoma is present, the retina may rest upon the surface of this, or be separated from it by some form of exudation, and also detached elsewhere. In any case the interval is frequently empty in preparations. Crystals of cholesterine and granular globular phosphatic masses have been seen in the subretinal fluid (Panas).

The detachment is partial and local, or "complete," when the membrane has a funnel-shaped arrangement, remaining attached only about the ora serrata and at the disc. In other instances it passes straight forwards as a cord or tube from the disc to the posterior pole of the lens, and then the anterior part spreads outwards, closely applied to the posterior surface of the lens and zonula, and backwards over the pars ciliaris retinæ to the ora, where it makes a sudden bend forwards at the junction with the pars ciliaris. Even the posterior attachment at the disc is in some cases wanting; and the retina, totally unconnected with the fundus, lies as a crumpled mass in the front part of the vitreous chamber. Extensive detachments are often found in eyeballs removed on account of cyclitis or intra-ocular tumours.

The retina is most commonly œdematous, apparently from imbibition of the fluid in which it has been immersed, so that, for instance, where there has been cyclitis leading to great detachment of the retina, it is softened and macerated, and appears as a spongy tissue with small empty spaces. In cases of ong standing the retina has been found unaffected. At a late date, however, the nervous elements usually have disappeared, and there is a formation of fibrous issue, the membrane ultimately having become hard, ough, and more or less distinctly fibrous, with some hick tendinous bands and granular areas, staining ringing into view elongated oval and round nuclei. In n advanced case of complete detachment the remains f the retina pass forwards from the disc as a dense brous cord, and the papilla may look as if dragged orwards slightly, while the inner layers of the choroid and even of the sclerotic reach for a short distance over the stalk of the retina. At the border of a cyclitic membrane the retina is often observed attached to this, folded up, and partially wasted; while, in other cases, it is curled up in the midst of the newly formed membranous mass, and sections display a loose net-work of fibres with nuclear elements.

In cases where there has been hæmorrhage, the products of the degeneration of the clot form granular masses, both large and small, of a reddish-brown colour, part of them finding lodgment in nucleated corpuscles.

The pigmented epithelium remains attached to the choroid, or adheres to the detached retina, in which some of its particles are frequently noticed.

Small nodules of the lamina vitrea choroideæ with hyaline excrescences sometimes occur in a detached retina; and calcareous deposit in the walls of the blood-vessels has been observed.

Wound of the Retina.—Apart from the changes in the sclerotic and choroid to which allusion has already been made, a wound in the retina causes circumscribed interstitial inflammation; and, if examined at an early date, the edges of the wound are infiltrated with round cells, while at the injured spot there is an exudation of fibrine and leucocytes. At a late period, after healing, a local formation of cicatricial tissue, which is sometimes stained with blood colouring matter, replaces the retinal layers; it is continuous with similar tissue in the choroid and sclerotic where these also have been wounded, while pigmented cells or traces of them, as free brown particles, are usually embedded in the cicatrix.

Opaque Nerve Fibres in the Retina.—An abnormality of the retinal nerve fibres in a spot adjoining the disc is known clinically under this name. In such an area some nerve fibres possess a sheath of the white substance of Schwann. They lose their medullary sheath as they enter the posterior border of the lamina cribrosa, but are again enveloped in it in front of this membrane or at a short distance from it, and then gradually or abruptly become once more free from the fatty tube (Virchow).

Tubercle of the Retina.—Miliary tubercles in the retina have been examined by Perls.

Connective-tissue Formation on the Retina.—Membranes and minute nodules of fibrous connective tissue form on the inner surface of the retina, as a result of chronic inflammatory changes.

Glioma of the Retina.—The name glioma retinæ was applied to this tumour on account of its origin from the neuroglia, or supporting tissue, which pervades the retina. Histologically, its characters agree with those of a small round-celled sarcoma; and, as it is malignant, infecting and destroying the various tissues of the eyeball, in an advanced case the point from which it sprung cannot be distinguished.

It is composed of granular round cells, with a large spherical nucleus, pressed against one another, and cemented together by a small quantity of molecular substance. A few cells of other forms are occasionally present, such as spindle-shaped and branched corpuscles; and some large spheroidal cells may also be discovered. It is very vascular, having many thin-walled blood-vessels or spaces, and hæmorrhages occur in it. Areas of the tumour frequently undergo fatty degeneration, and form caseous masses; and calcareous deposit has also been seen. Attacks of irido-choroiditis in the affected eye leave inflammatory products, round cells, granular coagula of serous fluid, fibrine, and hæmorrhages. In preparations mounted in glycerine the component cells with their round nuclei, which are not easily distinguished from the cell-substance, are found to be larger than the bright conspicuous nuclear elements of the retina, which they resemble in many respects. In stained specimens mounted in dammar the two kinds of deeply tinted nuclei are in some places very similar to one another, while in other parts, where the infiltration with the cells of the tumour is slight, the rounded outline of these distinguishes them from the oval or fusiform shape of the normal elements, and from the smaller round nuclei, which may be seen in the external nuclear layer. In sections stained with magenta and iodine green the nuclei of the glioma acquire a purplish tint.

It is exceedingly difficult to determine in some instances the precise retinal tissue, from which the growth has begun. Judging from the conditions at the margin of the tumour or of secondary nodules, or from minute isolated foci of infiltration in advance of the main mass, its starting-point is generally in the outer strata, in one of the nuclear layers; but it may commence among the nerve fibres, and has also been observed to arise from other layers, or in several together. The strata from which it has not originated may remain unaffected for a considerable time; but the malignancy of the disease does not spare them ultimately, and they are involved in the tumour, their proper structure being entirely lost.

The primary tumour is a mass of round cells, occupying the former situation of some part of the retina and encroaching on the vitreous ; separate secondary nodules of similar tissue replace the whole thickness of the retina at spots in the neighbourhood, for the growth extends not only by continuity, but also by centres at a little distance from the advancing margin. Still further from the original source there are, at intervals, minute points infiltrated with tumour elements, and it is here that it is possible to distinguish which layer is affected. Even in the same case one such focus may be in the internal nuclear, while another is obviously in the external nuclear layer, and a third is manifestly related to the blood-vessels or their sheaths among the nerve fibres ; or one collection may predominate in a given locality, while minor accumulations are present in other layers there also; or all the layers may apparently suffer simultaneously.

LENS.

I. NORMAL STRUCTURE.

THE lens is enclosed in a transparent, homogeneous, elastic *capsule*, varying in thickness at different parts, and described as thickest at the anterior and thinnest at the posterior pole. Near the margin the fibres of the *zonula of Zinn* join, and gradually sink into, the anterior surface of the capsule; and in flat preparations of this part their exact termination, as they ultimately lose themselves in the clear membrane, cannot usually be recognized. The anterior segment of the capsule is lined internally by a single layer of granular polygonal cells, the *epithelium*, each of which has a large round or somewhat oval nucleus with a nucleolus, cemented together by an intercellular substance, which stains with silver in the usual way. Towards the equator, these cells are progressively longer and more cylindrical, finally appearing as fibres of the lens.

The body of the lens is made up of *fibres*, which are flattened riband-shaped bands, transverse sections showing them to be hexagonal prisms, the broad sides of which, parallel with the surface of the lens, are considerably larger than the others. They are finely granular, and of different widths in different parts; and, running from before backwards in concentric laminæ, the external ones unite to form a series of successive shells round the central part or nucleus of the lens. The cortical fibres possess a granular oval nucleus with a nucleolus, and their edges are more smooth and even, while the harder fibres, which compose the central portion, have no nucleus, and their edges are often uneven or dentated, especially near the extremities of the fibres. In microscopical preparations some of the fibres are expanded at their ends.

The concentric lamellæ are intersected by sutures or lines, where the ends of one set of fibres meet those of another set; and, as these sutures are superimposed upon one another, the lens as a whole is divided into sectors along planes radiating from the centre, the arrangement producing a star-like figure, when the lens is viewed from before or behind.

There is some *cement-substance* between the fibres, most observable in the cortex, which can be readily demonstrated by staining with nitrate of silver. A *post-mortem* softening or deliquescence of the fibres yields the liquor Morgagni, which is seen as clear material in irregular drops or globules and masses.

II. Pathological Conditions.

Cataract.—Cataractous, opaque lenses present several histological varieties, although, from the unsatisfactory results of hardening and mounting in many cases, and the uncertainty attaching to many appearances in fresh specimens, it may remain doubtful whether some of the alterations recorded are not rather *post mortem* and artificial in their origin, or inferences from clinical and naked-eye observations.

Hard Cataract.—The affected fibres resemble those of the normal central mass, destitute of a nucleus, irregular in outline, thickened, and so adherent to each other that individual fibres are not easily isolated. They are mingled with accumulations of drops and dispersed globules of coagulated material.

Soft Cataract.—There is here an excess of fluid; the liquor Morgagni is increased; and the fibres, which appear swollen, perhaps from imbibition of fluid, may be varicose. They show degeneration, containing molecules and little globules; and are partly destroyed, fatty débris being set free. Some of them have irregular transverse striæ; and there are drops of clear material, occasionally with acicular crystals apparently of margaric acid.

Over-ripe Cataract.—In cases where an opaque lens has undergone further degeneration, there is generally, in addition to changes similar to those found in soft cataract, great shrinking of the lens substance, and a deposit of calcareous granules or of cholesterine crystals.

Anterior Polar or Pyramidal Cataract.—In this form there is a circumscribed, small, rather conical projection at the anterior pole of the lens, covered with the capsule, which is thinned at the summit. The epithelial lining is wanting locally. According to Becker, the apex is filled with coagulated serum and the base with spindle-cells; Müller and Schweigger say that it is occupied by a fatty and calcareous mass; and Alt describes the material in the apex as laminated and opaque, containing cells, and the substance in the base as fatty drops and calcareous granules, the base bulging backwards and the surrounding epithelium being normal. It would seem, therefore, from the discrepancies in the various records, that more than one kind of pyramidal cataract occurs.

Wound of the Lens.—If the capsule is wounded, so as to admit the entrance of fluid from the aqueous or vitreous humour, the substance of the lens becomes opaque, and this traumatic cataract belongs histologically to the soft variety. The fibres are swollen and excessively molecular, and at a later stage are broken down into particles. Masses of coagulated material with a cellular or vacuolated appearance are present, and the capsule is, in the majority of cases, partly rolled up, while the epithelium is quite normal, or in little accumulations, or absent.

If there is inflammation of the ciliary body or of some other part of the uveal tract, an exudation of fibrine and round cells, with areas of granular detritus, is found invading the lens; and in many instances an organized fibro-cellular formation occupies the former site of a portion of it. At other times pus occurs here. The capsule is confusedly curled up, and embedded in, or attached to, a cyclitic or iritic membrane; and union between the lens and the iris or cornea, by means of inflammatory material, is common. Calcareous deposit may be found among the remains of the lens fibres; and spicules of bone have been observed, where ossification has taken place in the fibrous new-formation (Wagner).

Cellular or fibrous inflammatory products, attached to portions of the capsule, and mixed with degenerated fibres of the lens, sometimes form secondary membranes or capsular opacities behind the pupil after an operation for cataract.

Inflammatory Deposits not unfrequently remain connected with the surface of the capsule after iritis, and are composed of collections of uveal pigment as black clumps and free particles, granular débris, and delicate fibrous tissue. Adhesion between the lens and the iris, constituting synechia posterior, has been already considered under "Iritis."

The centre of the anterior surface of the capsule may have attached to it traces of an inflammatory exudation, left there at a former period, when the lens was locally applied to the cornea at a perforation in the latter. This is described clinically as "anterior polar cataract."

When the lens has been pushed forwards, and a portion of the capsule for a long time pressed against the cornea, as, for example, in some cases of staphyloma anterior, adhesions may be found between them.

Inflammatory shreds are occasionally present on the posterior aspect of the lens after cyclitis; the greater changes brought about by inflammation of the ciliary body are noticed in connection with that subject.

DEVELOPMENT OF THE EYE.

In this sketch only the more important points connected with the formation of the eye, and apparently established, are noted. The illustrations of the earlier stages are taken from that most convenient field of study, the hen's egg.

The *blastoderm*, or embryonic area on the surface of the ovum, is composed of three layers—viz., the epiblast, mesoblast, and hypoblast; and, as the eye is formed from the two outer layers, it contains epiblastic and mesoblastic elements. The middle of the blastoderm is more transparent than the margin, and about the centre of this *area pellucida* the first trace of the embryo is a slight local thickening of the epiblast and mesoblast, forming a comparatively opaque line, the *primitive streak*. This shortly afterwards has a furrow along its surface, the *primitive groove*. A similar thickening and furrowing occur immediately in front of one end of the primitive groove, and result in the formation of the *medullary groove*, bounded by lateral ridges, which receive the name of *laminæ dorsales*. These ridges become higher, and bend over towards one another, meeting first towards that end of the groove, which ultimately becomes the cephalic extremity of the embryo, and which their union converts into a tube. After contact of their edges has occurred, the layer of epiblast, which originally lined the medullary groove, separates from its continuation covering the outer aspect of the laminæ dorsales, the former being left isolated as the lining of the *medullary canal*, beneath the latter, which roofs it over as a separate external continuous sheet.

The cephalic end of the tube is soon closed, and dilates into a bulb, which is the first stage in the formation of the brain, and is called the *anterior cerebral vesicle* and afterwards the thalamencephalon. This expands at both sides; and the expansions, becoming marked off by constrictions from the anterior cerebral vesicle, turn downwards and backwards, and form the *primary optic vesicles* with short pedicles; but their internal cavities remain in communication with that of the central vesicle through the hollow stalks, which afterwards pass inwards from the optic vesicles, and ultimately become the optic nerves. All of these structures are derived from the involuted epiblast beneath, and separate from, the external epiblast; and they are composed of several layers of somewhat columnar cells.

At a spot in front of each primary optic vesicle the external epiblast becomes thickened and depressed; and this shallow pit lies in a corresponding hollow in the adjacent wall of the vesicle. This hollow increases in depth, until the anterior segment of the vesicle bulges backwards instead of forwards, and almost touches the posterior, and there is formed a cup with double walls. This is the *optic cup*, and the inner wall of this *secondary optic vesicle* is transformed into the retina, while the outer or posterior one becomes the pigmented epithelium. Owing to the fact that the invagination of the optic vesicle takes place not directly from before backwards straight towards the stalk, but rather from below upwards and backwards simultaneously, a cleft or slit is, in the subsequent growth, left along the under surface of the cup from its open mouth to the pedicle. This is the *choroidal fissure.*

The thickened portion of the external epiblast is more and more deeply depressed until, the mouth of the little pit closing, it is a small sac. It is then detached from the rest of the outer epiblast, which passes over it as an uninterrupted layer, just as happens with the medullary canal. This sac is the rudiment of the *lens*, and at first it nearly fills the optic cup ; but afterwards, as the latter enlarges, it lies in the mouth of the cup, and the space behind it is occupied by vascular rather fibrous tissue in the place of the future vitreous.

The walls of the optic cup, as they grow, cease to resemble one another, the inner being much thicker and presenting large numbers of nuclei and delicate fibres passing vertically between its surfaces, while the outer remains thin, and is the seat of a granular pigmentary deposit. The situation of the choroidal fissure is easily distinguished, even after the cleft is in reality closed, from the absence for some time of pigment along this line from the edge of the cup to the optic stalk. A congenital absence of part of the choroid and of the iris, known as coloboma choroideæ and coloboma iridis, has been referred to arrested development in this region. The optic stalk undergoes a somewhat similar process to that traced in the formation of the optic cup. It becomes flattened, and the original central canal is obliterated by thickening of the walls. It is then folded lengthways so as to enclose a new canal continuous with the cavity of the vitreous chamber through the hinder end of the choroidal fissure. The optic cup is surrounded by mesoblast consisting of branched irregular cells, the inner portion of which becomes the *choroid* with its branched pigmented cells, and the outer portion of which forms the *sclerotic.*

Anterior to the line, which is afterwards the position of the ora serrata, the epiblastic elements of the optic cup, blended with the mesoblast immediately outside of them, are thrown into folds behind the margin of the lens, and these form the processes of the *ciliary body.* A continuation of this anterior epiblastic portion passes inwards in front of the lens to become part of the *iris*, and narrows the opening or mouth to the aperture, which remains permanently as the pupil. Pigment is deposited in the layers in this region, which are said to become the uveal layer of the iris and ciliary processes and also the pars ciliaris retinæ, while the rest of the ciliary body and iris, with their muscles, vessels, connective fibres, and corpuscles, is derived from the mesoblastic layer continuous with the choroid.

Cornea.—The anterior epithelium of the cornea is produced from the external epiblast and the substantia propria from the mesoblast. A ring of homogeneous material forms round the edge of the optic cup in front of the lens, and spreads towards the centre, until it is a continuous covering or lid; and behind this a layer of cells appears to grow from the corresponding edge of the mesoblast in the situation of the posterior epithelium. Then the mesoblast round the plate of homogeneous substance becomes divided into two layers, the posterior one extending inwards as the stroma of the *iris* immediately in front of the lens, while the anterior one spreads similarly as a layer of corpuscles in the midst of the transparent corneal substance, which is then split into two strata, which become ultimately the membranes of Bowman and Descemet respectively, while the corpuscles develop into the substantia propria, which is therefore continuous with the mesoblastic structures.

Lens.—In its early stage the lens is a vesicle with a central cavity, the walls consisting of a single layer of columnar cells derived from the epiblast, as already mentioned. Those in the anterior portion become somewhat flattened, and remain as the epithelium lining this segment of the capsule. Those in the posterior portion become elongated into fibres, until they touch the anterior layer and obliterate the cavity, a ring of the original space at the equator of the lens seeming to be the last part obliterated. The nuclei of the cells persist as the nuclei in the anterior or nuclear zone, and continued elongation and multiplication of the cells yield the fibres of the lens, from many of which the nuclei disappear, while the lens assumes more and more of its mature rather flattened shape, and increases by the formation of new fibres towards the margin. In hardened specimens the fibres stop at some distance from the posterior wall of the lens, and the remaining space contains globules of a coagulated material, in which there are many vacuoles, and which is apparently derived from the softened posterior extremities of the fibres. The capsule seems to be either deposited by the epithelial cells of the lens (Kölliker), or to arise from some mesoblastic cells carried in with the lens, which also form the zonula of Zinn (Lieberkühn).

Vitreous.—The embryonic vitreous is a substance, chiefly fluid and sometimes with a few cells, originating from a vascular growth of mesoblast, which extends into the interior of the optic cup through the choroidal fissure. At a later date a continuation of the blood-vessels, which are afterwards enclosed in the folded optic nerve, is found passing forwards through the vitreous humour to the posterior aspect of the lens, where it gives off branches, which run round the edge to the anterior surface, and anastomose with those of the iris. This vascular sheath of the lens is called the *membrana capsulo-pupillaris*, and the posterior half of it is almost entirely composed of vessels, while the anterior segment has in addition a delicate stroma continuous with the posterior corneal epithelium, and constitutes the *membrana pupillaris*, which, on the formation of the iris, lies in front of the latter. These structures disappear before birth, although in rare cases persistent fragments of the pupillary membrane are observed, and portions of what appear to be remains of the vessels passing forwards from the disc have been seen in the mature vitreous.

Retina.—The thickened anterior or inner wall of the optic cup, consisting of nuclei, fibres, and several layers of spindle-shaped cells, with some fibrous tissue at the surface, is afterwards differentiated into the various layers of the retina.

Pigmented Epithelium.—The posterior or outer wall of the optic cup, on the other hand, is reduced to a single layer of cells, in which dark granules of pigment are deposited, and the shape of the cells becomes more or less hexagonal.

Optic Nerve.—When the nerve fibres have appeared in what was formerly the stalk of the optic vesicle, the connection with the outer wall of the optic cup is no longer seen; and the nerve, passing through this, is continuous with the inner wall with its retinal layers. This perforation or opening is the only portion of the choroidal fissure which is left permanently, the rest closing entirely and being obliterated. Blood-vessels are enclosed in the longitudinally folded optic nerve, and pass with it into the vitreous chamber, finally forming the arteria centralis retinæ and its vein, branching in the retina.

Eyelids.—The eyelids are developed from folds of the external epiblast with an enclosed layer of mesoblastic elements.

MEASUREMENTS.

Eyeball.

	Jaeger.	Henle.	Merkel's Schema.
Antero-posterior diameter	24·3 mm.	24· mm.	24·3 mm.
Horizontal „	23·6 „	23·5 „	23·6 „
Vertical „	23·4 „	23·1 „	23·4 „

Diameters of Cases (Jaeger) :—

	Ant.-post.	Horizontal.	Vertical.
Child 4 days old	16·3 mm.	15·7 mm.	15· mm.
„ 31 „ „	17·6 „	17· „	16·4 „
Female 19 years „	24·2 „	23·1 „	24·3 „
„ 28 „ „	23·2 „	23·2 „	22·4 „
„ 31 „ „	22·4 „	21·8 „	21·5 „
Male 16 „ „	23·2 „	23·1 „	23·5 „
„ 23 „ „	24·7 „	23·4 „	24· „
„ 40 „ „	24·3 „	23·8 „	23·6 „

Cornea.

	Jaeger.	Henle.	Merkel's Schema.
Diameter	12· mm.	11 mm.	11·6 mm.
Thickness at centre	·9 „	1 „	·9 „
„ near margin	1·2 „	—	1·1 „

Thickness of ant. epithelium ·03 mm., of Bowman's membrane ·0045—·01 mm. (Henle).

Thickness of Descemet's membrane about centre ·006—·008 mm., near margin ·01—·012 mm. (Müller).

Sclerotic.

	Jaeger.	Henle.	Merkel's Schema.
Thickness of posterior part	1·1—1·2 mm.	1 mm.	1 mm.
„ anterior „	·7 „	·3 „	·4 „

Iris.

Thickness near pupil ·4 mm., middle ·3 mm., periphery ·2 mm. (Jaeger).

Breadth after death 3·5—4·5 mm.

Sphincter, breadth ·8—1 mm., thickness ·07—·25 mm.

Pupil, diameter 4 mm. (Jaeger), 4·5 mm. (Henle), 4 mm. (Merkel's Schema).

Choroid.

Thickness near disc ·12—·15 mm. (Jaeger), ·07 mm. (Henle), ·09 mm. (Merkel's Schema).

„ near margin ·06 mm. (Merkel's Schema).

„ of lam. vitrea ·0006—·0008 mm.

Pigmented Epithelial Cells.

Size 12—18 micro-mm., thickness 9 micro-mm.

Length of pigment particles 1—5 micro-mm.

Ciliary Muscle.

	Jaeger.	Henle.	Merkel's Schema.
Greatest thickness	·9 mm.	1 mm.	1 mm.
Length	3·5 „		

Optic Nerve.

Diameter behind eyeball, with sheath, 3·9—4·3 mm., thickness of outer sheath ·5 mm.

„ through sclerotic 1·5 mm., at level of choroid 1·2 mm.

Optic Disc.

Diameter 1·2—1·6 mm. (Jaeger), 1·4 mm. (Henle), 1·4 mm. (Merkel's Schema).

Retina.

Thickness in millimètres (Müller).

	At distance from disc of ·5 mm.	8 mm.	18 mm.
Whole retina ...	... ·428	... ·216	... ·140
Nerve-fibre layer	... ·2	·025—·028	·04—·045
Nerve-cell „	... ·015		
Int. molec. „	... ·036—·04	...	
„ nuclear „	... ·033—·038	...	... ·016—·02
Ext. molec. „	... ·03—·04	...	... ·012—·016
„ nuclear „	... ·045—·065	...	... ·025
Rods and cones	... ·05	... ·045	... ·04

Thickness of nerve fibres ·5—3 or 5 micro-mm. (Schultze).

Size of nerve cells 15—30 micro-mm. ... ... „

Length at fundus of rods 50—60 micro-mm., of cones 32—36 micro-mm. ... ... „

Thickness at fundus of rods 2 micro-mm., of cones 6—7 micro-mm. ... ... „

Thickness at fovea of cones 3 micro-mm., length 60—100 micro-mm. ... ... „

Lens.

	Jaeger.	Henle.	Merkel's Schema.
Antero-posterior diameter	3·7 mm. ...	4 mm. ...	3·7 mm.
Transverse „	10·3 „ ...	9·5 „ ...	9 „

Capsule, thickness at ant. pole ·011—·018 mm., at post. pole ·005—·008 mm.

Epithelial cells, size ·019—·032 mm.

Fibres, breadth of cortical ·01—·012 mm., of central ·007—·008 mm.

„ thickness of cortical ·0045—·0055 mm. „ ·0023 ·0028 „

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PLATE I.

Fig. 1.—Vertical Section, in outline, of Upper Eyelid.

× 6 diam. Dammar preparation.

1. Skin with hairs and sweat-glands. 2. Orbicularis palpebrarum muscle. 3. Subcutaneous fat. 4. Fat beneath orbicularis. 5. Involuntary muscular fibres behind tarsus, near fornix. 6. Conjunctiva palpebræ. 7. Mouth of Meibomian gland, in tarsus, at edge of lid. Above and below the duct is seen the musculus ciliaris Riolani. 8. Eyelashes.

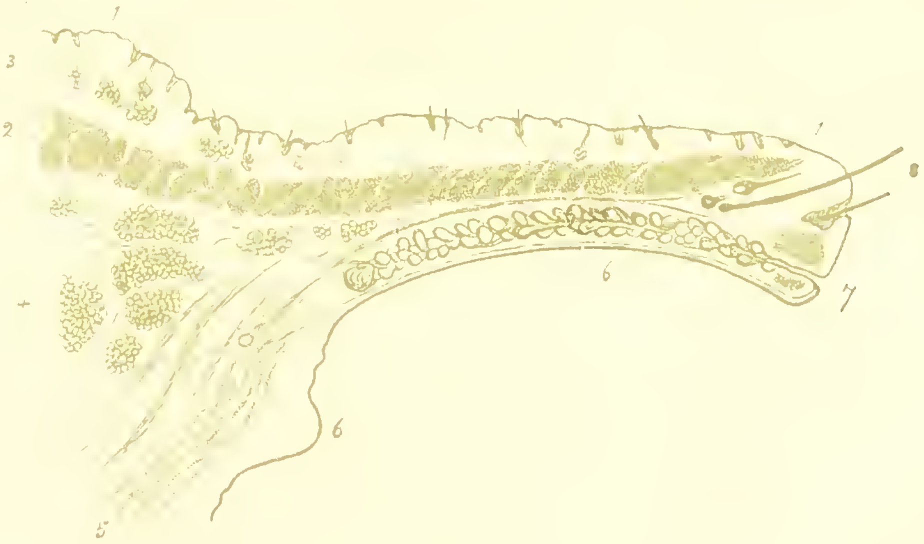

Fig. 1.

PLATE II.

Fig. 2.—Vertical Section, in outline, of Lower Eyelid.

× 6 diam. Dammar preparation.

1. Skin with hairs and sweat-glands. 2. Orbicularis palpebrarum muscle. 3. Subcutaneous fat. 4. Fat beneath orbicularis. 5. Involuntary muscular fibres behind tarsus. 6. Conjunctiva palpebræ. 7. Mouth of Meibomian gland, in tarsus, at edge of lid. Above and below the duct is seen the musculus ciliaris Riolani. 8. Eyelashes.

Fig. 3.—Vertical Section of Epithelium of Conjunctiva Bulbi of Negro.

× 300 diam. Glycerine preparation.

1. From behind limbus conjunctivæ. Pigment in deepest cells. 2. From posterior part of limbus conjunctivæ. Pigment in cells of different layers. 3. From anterior part of limbus conjunctivæ, near cornea. Pigment in various layers.

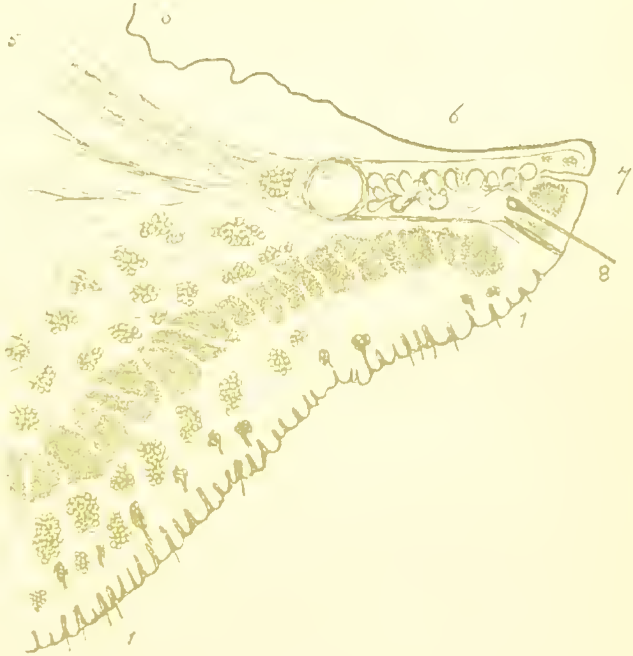

Fig. 2.

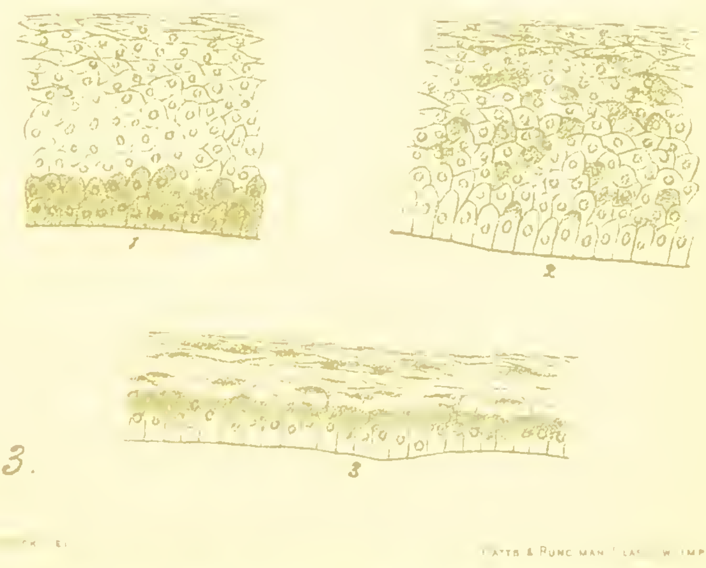

Fig. 3.

[illegible] del.
Watts & Runciman Glasgow imp.

PLATE III.

Fig. 4.—Vertical Section of the Edge of Upper Eyelid.

× 30. Dammar.

1. Skin. 2. Anterior part of orbicularis palpebrarum muscle, cut transversely. 3. Musculus ciliaris Riolani, cut transversely. Some fibres of this muscle are seen beneath the Meibomian gland. 4. Internal or conjunctival surface of tarsus; fibrous tissue. 5. Conjunctiva; connective tissue and stratified epithelium. 6. Inner angle of free edge of lid. 7. Eyelashes in follicles. 8. Gland of Moll. 9. Meibomian gland. 10. Duct of Meibomian gland, opening on free edge of lid.

Fig. 5.—Section of Racemose Gland in Fornix Conjunctivæ.

× 45. Dammar.

1. Lobules of gland. 2. Duct, cut across. 3. Loose connective tissue.

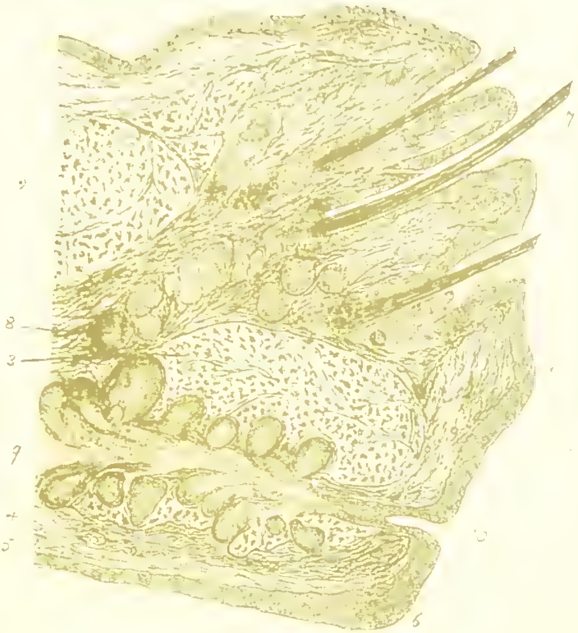

Fig. 4.

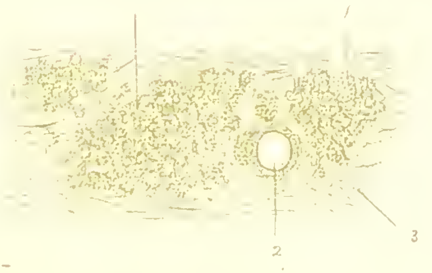

Fig. 5.

[illegible] [illegible] GLASGOW [illegible]

PLATE IV.

FIG. 6.—Part of Longitudinal Section of Meibomian Gland in Upper Eyelid.

× 45. Logwood, Dammar.

1. Epithelium of conjunctiva. 2. Sub-epithelial connective tissue. 3. Internal surface of tarsus; dense fibrous tissue, with blood-vessels. 4. Anterior part of duct of Meibomian gland. 5. Posterior part of Meibomian gland. 6. External surface of tarsus. 7. Connective tissue outside tarsus, with transverse section of an artery.

FIG. 7.—Vertical Section of Racemose Glands in posterior part of Tarsus of Upper Eyelid.

× 45. Logwood, Dammar.

1. Epithelium of conjunctiva. 2. Sub-epithelial connective tissue. 3. Internal layers of tarsus, with blood-vessels. 4. External surface of tarsus. 5. Posterior border of tarsus. 6. Lobules of glands.

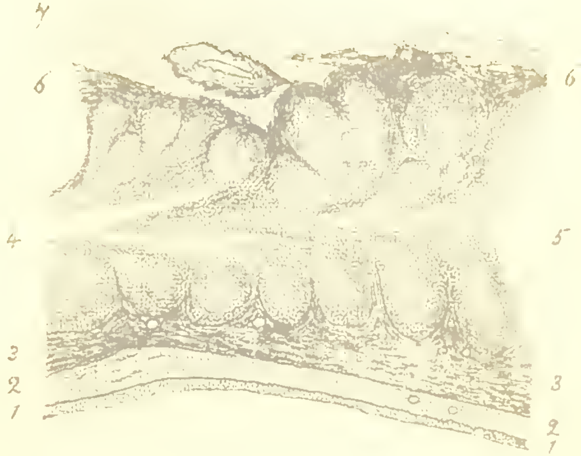

Fig. 6.

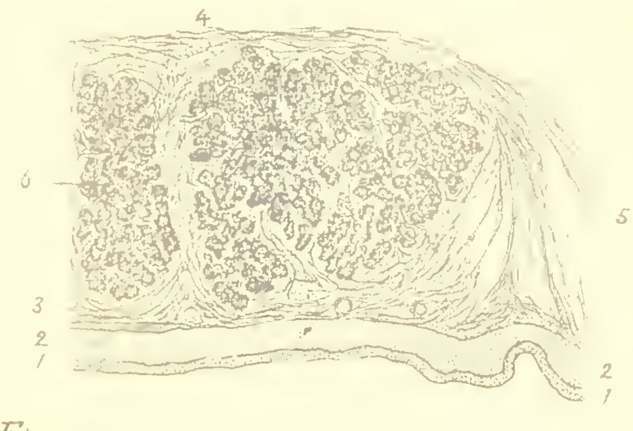

Fig. 7.

Fred P[illegible]

[illegible]

PLATE V.

Fig. 8.—Vertical Section of Chalazion (Meibomian Cyst).

× 10. Glycerine.

1. Stratified epithelium, continued over the surface. 2. Connective tissue outside tumour. 3. Capsule of fibrous tissue, from which septa pass inwards, dividing the cyst into lobules. 4. Epithelial cells inside capsule. 5. Fatty material occupying centre of lobules, the outer layers being more opaque.

Fig. 9.—Part of Sebaceous Cyst in Upper Eyelid.

× 300. Glycerine.

1. Trabeculæ of fibrous tissue. 2. Epithelial cells. Only those in the outer layer are well defined. 3. Fatty bodies and granular material. 4. Opaque fatty bodies and granular substance.

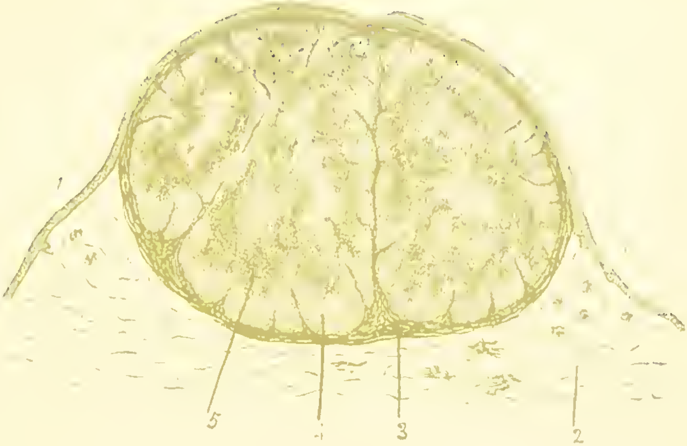

Fig. 8.

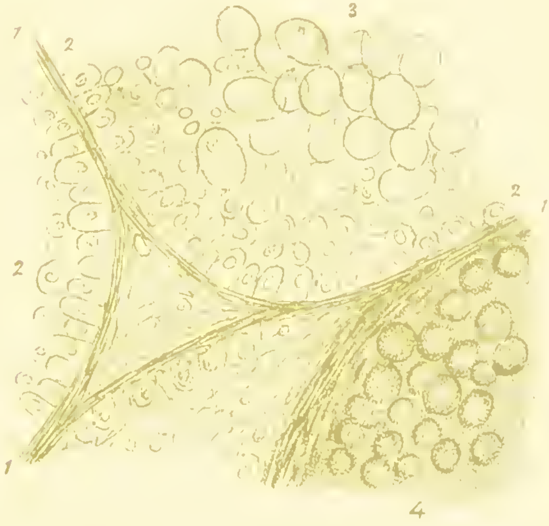

Fig. 9.

C. Fred Pollock, del.

atts & Runciman [illegible]

PLATE VI.

FIG. 10.—Vertical Section of Epithelioma of Lower Eyelid.

× 30. Logwood, Dammar.

1. Normal epidermis. 2. Subcutaneous tissue. 3. Hair-follicles and hairs. 4. Sweat-glands. 5. Epithelioma, with processes extending from the deeper surface. 6. Subcutaneous tissue, with infiltration of inflammatory round cells.

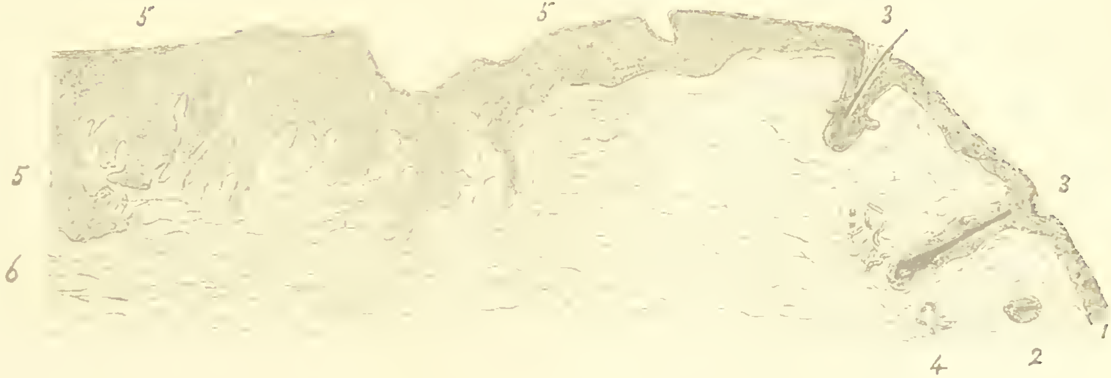

Fig. 10.

PLATE VII.

Fig. 11.—**Vertical Section of Sarcoma of Lower Eyelid.**

× 30. Dammar.

1. Normal epidermis, with hair-follicles. 2. Atrophied epidermis over tumour. 3. Epithelial scales. 4. Subcutaneous tissue with sweat-glands. 5. Tumour (sarcoma).

Fig. 12.—**Cells from Sarcoma of Eyelid.**

× 300. Glycerine.

These are from a portion of the tumour drawn in Fig. 11, teased out. Both spindle-shaped and round cells are present.

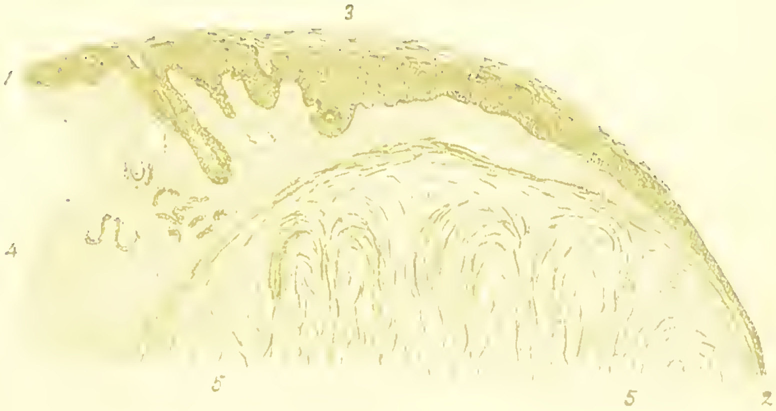

Fig. 11.

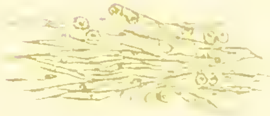

Fig. 12.

Alfred Pollock del.

Oatts & Runciman, Glasgow, Imp.

PLATE VIII.

FIG. 13.—Vertical Section of the Wall of an Orbital Dermoid Cyst.

× 30. Glycerine.

1. Contents of cyst; epithelial scales and fine hairs. 2. Stratified epithelium, lining cyst. 3. Fibrous capsule, with hair-follicles and hairs. 4. Connective tissue outside tumour. 5. Fat and blood-vessel. 6. Striated muscular fibres, cut transversely.

FIG. 14.—Vertical Section of Skin of Lower Eyelid with Xanthelasma Palpebrarum and Sebaceous Cyst.

× 30. Glycerine.

1. Epidermis with hair-follicles. 2. Subcutaneous tissue with some large fatty cells, collections of pigment, and scattered pigmented cells. 3. Cyst, containing epithelial scales and sebaceous material. 4. Stratified epithelium lining the cyst, with root of hair embedded in it. 5. Large cells with fatty contents outside fibrous capsule of cyst. 6. Subcutaneous tissue with portions of hairs.

Pl. VIII

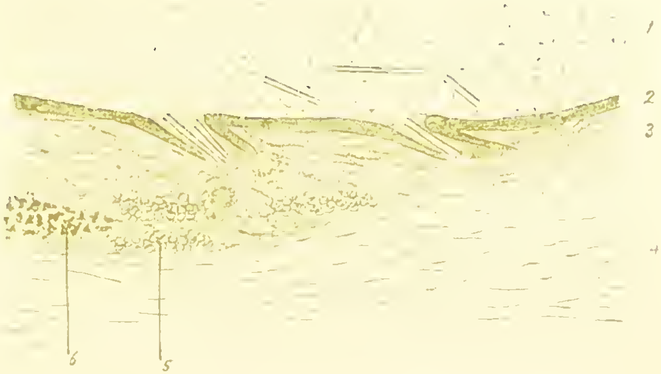

Fig. 13.

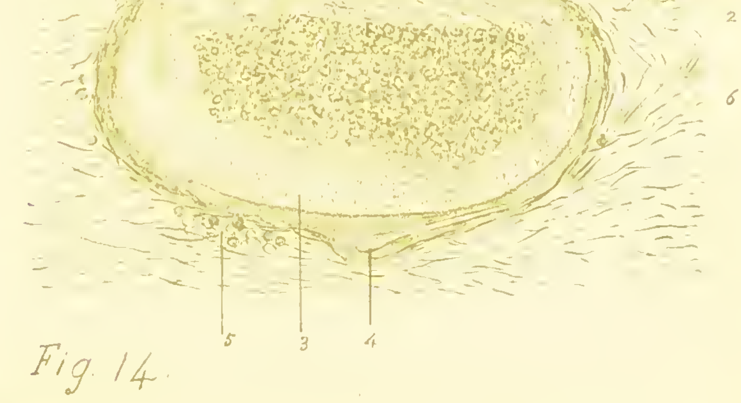

Fig. 14.

ATTS & RUNCIMAN GLASGOW IMP

PLATE IX.

Fig. 15.—**Phtheiriasis Palpebrarum.**

× 30. Glycerine.

Attached to an eyelash by cementing substance *c*, there is a nit, *b*, containing an immature pediculus. The operculum is wanting.

Fig. 16.—**Phtheiriasis Palpebrarum.**

× 30. Glycerine.

1. *a*. Operculum of nit. *b*. Nit with granular contents. *c*. Attachment to eyelash. 2. Empty nit, without operculum. 3. Young pediculus.

Fig. 17.—**Phtheiriasis Palpebrarum.**

× 30. Glycerine.

Mature female pediculus, grasping eyelash.

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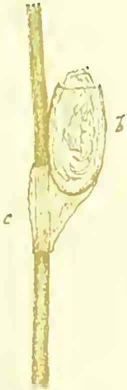


Fig. 15.

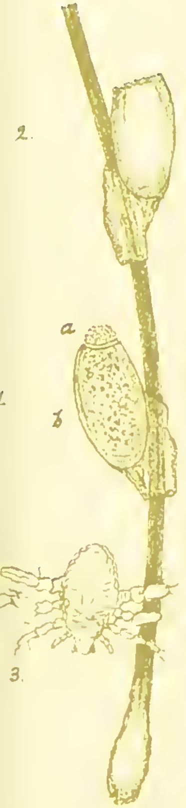


Fig. 16.

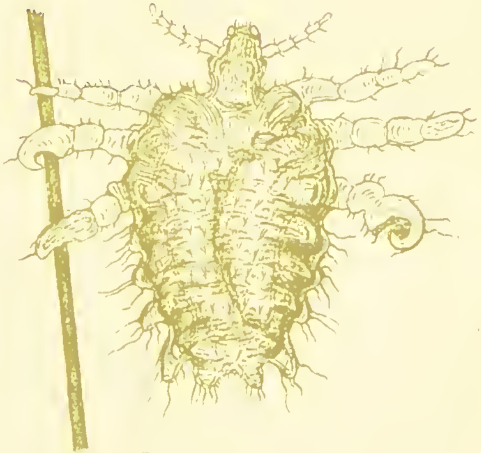


Fig. 17.

Fred. [illegible]

Watts & Runchman C[illegible]

PLATE X.

Fig. 18.—Vertical Section of Conjunctiva with Muco-purulent Conjunctivitis.

× 200. Glycerine.

This is from a child, eleven months old, who died nine days after the onset of measles.

1. Epithelium. 2. Sub-epithelial tissue, infiltrated with inflammatory round cells.

Fig. 19.—Vertical Section of Conjunctiva of Upper Lid with Purulent Conjunctivitis.

× 45. Glycerine.

This is from a girl, five years of age, who died from meningitis after scarlet fever. The eye became affected on the seventeenth day from the beginning of the scarlatina; and remained inflamed till death, five weeks later.

1. Internal surface with prominent elevations. 2. Subconjunctival tissue with dilated vessels.

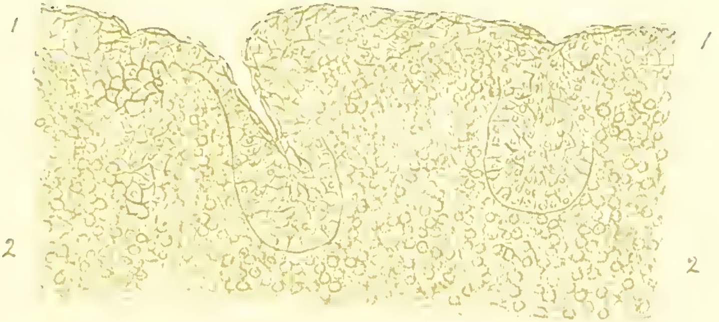


Fig. 18.

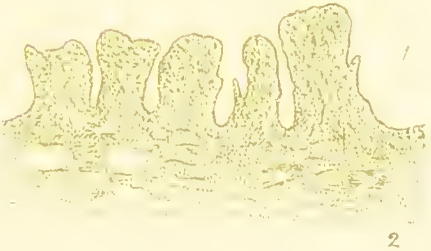


Fig. 19.

[illegible]

Watts & Runciman, Glasgow [illegible]

PLATE XI.

Fig. 20.—**Vertical Section of Conjunctiva of Eyelid with Granular Conjunctivitis (Trachoma).**

× 30. Logwood, Dammar.

1. Epithelium. 2. Inflammatory cells on surface without epithelium. 3. Round cells and traces of epithelium. 4. Sub-epithelial infiltration of leucocytes. 5. Trachoma follicle; spherical mass of round cells. 6. Connective tissue with blood-vessels, and some round cells especially about the follicle.

Fig. 21.—**Vertical Section of Conjunctiva of Eyelid with Granular Conjunctivitis (Trachoma).**

× 30. Logwood, Dammar.

1. Epithelium, continued over entire surface of elevation. 2. Depression between two adjacent follicles. 3. Sub-epithelial infiltration of inflammatory round cells. 4. Two trachoma follicles in the same prominence. 5. Connective tissue with blood-vessels and a few leucocytes.

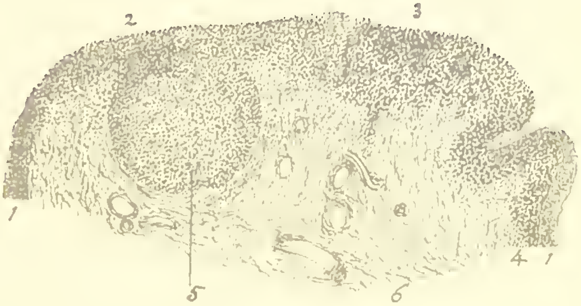


Fig. 20.

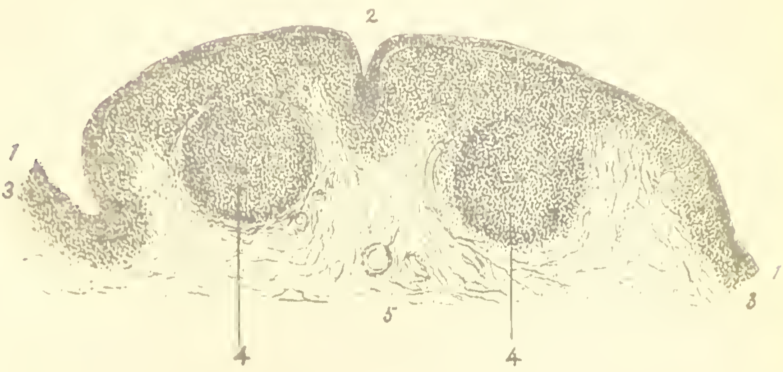


Fig. 21.

Fred Pollock del.

Oatts & Runciman, Glasgow. Imp.

PLATE XII.

Fig. 22.—Vertical Section of Conjunctiva of Lid with Chronic Conjunctivitis and Hypertrophy.

× 30. Logwood, Dammar.

1. Epithelium, continued over irregular prominences on surface. 2. Sub-epithelial tissue, infiltrated with round cells. The surface has in section the appearance of papillæ; the boundary between round cells and epithelium is not everywhere distinct. 3. Thickened sub-epithelial tissue with many blood-vessels and some collections of leucocytes.

Fig. 23.—Vertical Section of Limbus Conjunctivæ with Episcleritis and Conjunctivitis.

× 30. Logwood, Dammar.

This is from an eye, in the ciliary region of which a piece of iron lodged after passing through the cornea, iris, and lens. Inflammation of the iris, ciliary body, and choroid, with great chemosis, followed; and nineteen days after the accident the eyeball was removed.

1. Sclerotic. 2. Cornea. 3. Anterior epithelium of cornea. 4. Epithelium of conjunctiva. 5. Great swelling outside sclerotic. It is partly due to œdema (chemosis), partly to inflammatory exudation outside the sclerotic (episcleritis), and partly to inflammatory infiltration of the conjunctiva (conjunctivitis). There are many blood-vessels. 6. Loose connective tissue with some round cells.

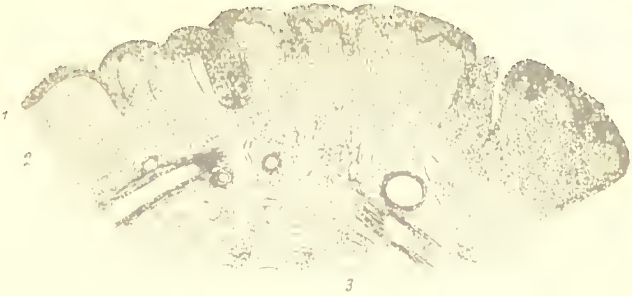


Fig. 22

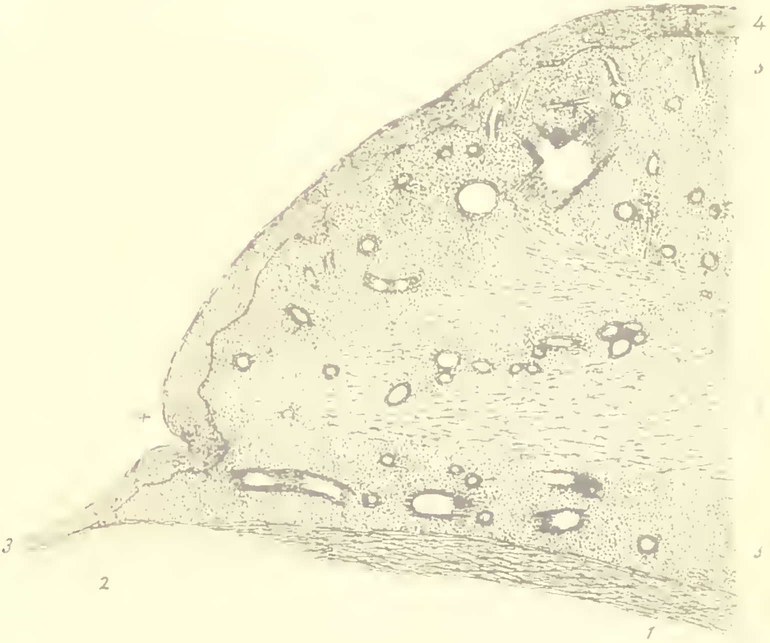


Fig. 23.

[illegible]

Oatts & Runciman Glasgow, Imp.

PLATE XIII.

Fig. 24.—**Vertical Section of Cornea.**

× 120. Glycerine.

1. Anterior epithelium, stratified. 2. Bowman's membrane. 3. Substantia propria with fusiform spaces between the lamellæ. The anterior layers are more fibrous and irregular. 4. Descemet's membrane. 5. Posterior epithelium, single layer.

Fig. 25.—**Isolated Cells from Anterior Epithelium of Cornea.**

× 300. Glycerine.

1. From anterior layers, surface view; flattened cells.
2. From deep middle layers, side view; roundish with processes.
3. From deepest layer, side view; columnar with flat base.

Fig. 26.—**Surface of Anterior Epithelium of Cornea.**

× 300. Silver, Glycerine.

This is from the cornea of an albino rabbit. The intercellular substance is stained with the silver.

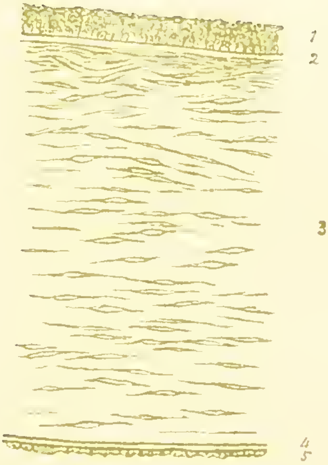


Fig. 24.

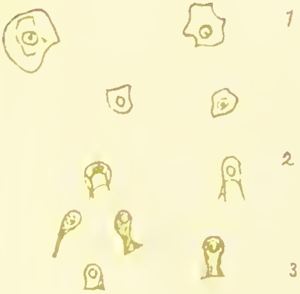


Fig. 25.

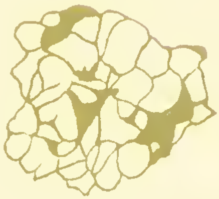


Fig. 26.

Fred Poll [illegible]

Oatts & Runciman, Glasgow, Imp.

PLATE XIV.

Fig. 27.—Lacunæ in Cornea.

× 300. Silver, Glycerine.

This is from the cornea of a rabbit, viewed from the posterior surface.

1. Substantia propria, stained with silver. 2. Lymphatic spaces.

Fig. 28.—Fibres of Cornea.

× 300.

This is from a cornea, macerated in a solution of bichromate of potash, and teased out in acetate of potash solution.

Fig. 29.—Posterior Epithelium of Cornea.

× 300. Silver, Glycerine.

This is from the cornea of an albino rabbit. The intercellular substance is stained with the silver; and some pseudostomata are seen. The nuclei of some of the cells are well defined.

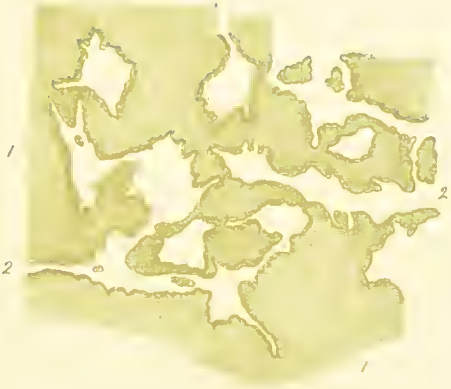


Fig. 27.

Fig. 28.

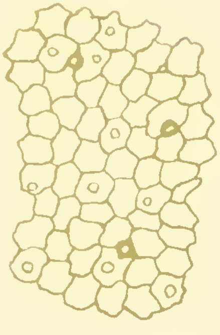


Fig. 29.

Jas. Pollock del.

Jas. & S. Runciman Glasgow imp.

PLATE XV.

Fig. 30.—**Vertical Section of Cornea.**

× 200. Logwood, Dammar.

1. Anterior epithelium, nuclei stained deeply. 2. Bowman's membrane, undefined. 3. Substantia propria, with lacunæ. The elongated nuclei of the corneal corpuscles and the round nuclei of the lymphoid cells are stained deeply. 4. Descemet's membrane. 5. Posterior epithelium.

Fig. 31.—**Corneal Corpuscles.**

× 400. Gold, Logwood, Glycerine.

These are from the cornea of a frog. A nerve fibril is seen crossing the corpuscle on the right side.

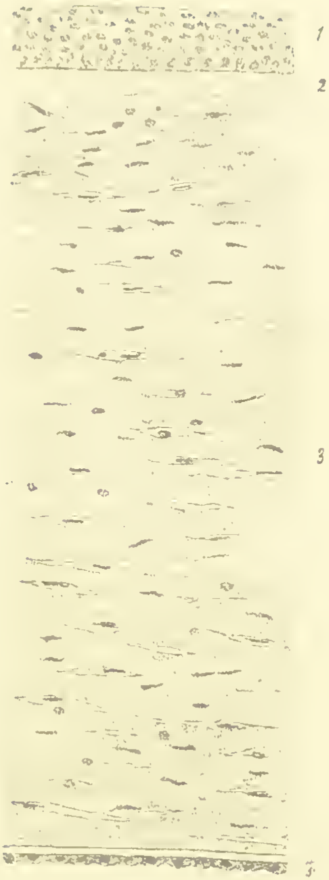


Fig. 30.

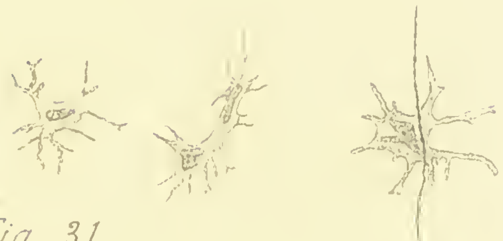


Fig. 31.

WATTS & RUNCIMAN, GLASGOW [illegible]

PLATE XVI.

FIG. 32.—**Vertical Section of Cornea with Inflammatory Infiltration.**

×200. Glycerine.

1. Lamellæ of cornea, between which there are round cells, singly or in groups. 2. Larger collection of round cells, and transverse section of thin-walled blood-vessel.

FIG. 33.—**Vertical Section of Cornea with Purulent Keratitis.**

× 55. Glycerine.

1. Anterior epithelium, irregular. 2. Bowman's membrane, uneven and interrupted. 3. Descemet's membrane, bending outwards. 4. Substantia propria, with groups of round cells and some blood-vessels. 5. Dense mass of pus. This is at the margin of a large perforation in the cornea.

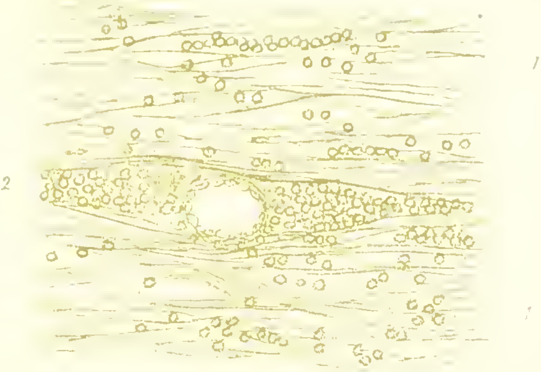


Fig. 32.

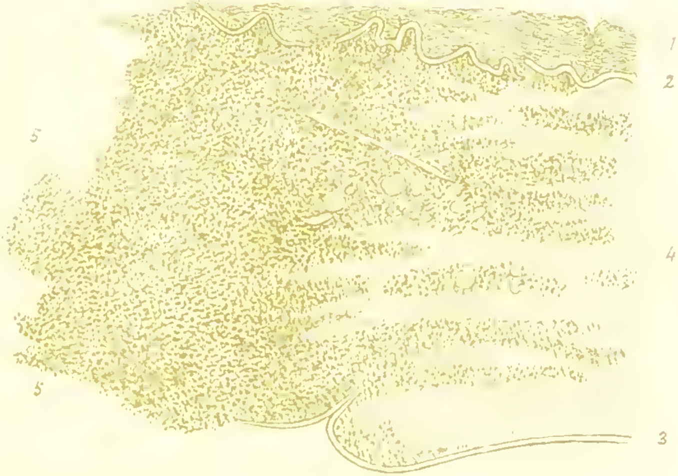


Fig. 33.

J. Fred Pollock del.

Jatte & Runciman Glasgow imp.

PLATE XVII.

Fig. 34.—Vertical Section of anterior portion of Cornea with Pannus and Leucoma.

× 55. Glycerine.

1. Anterior epithelium, irregular. 2. Thick sub-epithelial layer of round cells with some blood-vessels (pannus). 3. In this region there are many blood-vessels and also fragments of Bowman's membrane. 4. Substantia propria, replaced by cicatricial tissue (leucoma) with blood-vessels.

Fig. 35.—Vertical Section of anterior portion of Cornea with Pannus.

× 300. Glycerine.

1. Anterior epithelium. 2. Thin sub-epithelial layer of round cells. 3. Anterior layers of substantia propria. Bowman's membrane is not seen.

Fig. 36.—Vertical Section of posterior portion of Cornea with Descemetitis.

× 200. Glycerine.

1. Posterior layer of substantia propria, with some round cells. 2. Descemet's membrane. 3. Large round cells in irregular heaps in place of posterior epithelium.

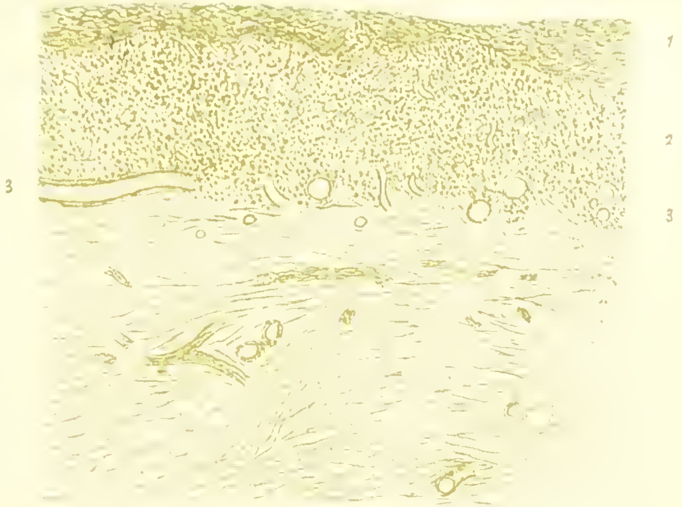


Fig. 34.

Fig. 35.

Fig. 36.

Fred Pollock del.

Oatts & Runciman Glasgow Lith.

PLATE XVIII.

Fig. 37.—Vertical Section of anterior portion of Eyeball with Corneal Staphyloma.

× 9. Glycerine.

This is from a woman, forty-five years of age, with a large staphyloma of the cornea of long standing.

1. Conjunctiva. 2. Sclerotic. 3. Ciliary body. 4. Iris, much thinned and atrophied. The periphery is pressed against the cornea, and the anterior chamber is almost obliterated. 5. Anterior corneal epithelium at edge of staphyloma, over which it is continued as an irregularly thickened layer. 6. Most prominent part of staphyloma. 7. Posterior margin of staphyloma. Descemet's membrane ceases at this point; and the iris becomes adherent to the dense fibrous tissue (leucoma), which has replaced the substantia propria. The staphyloma is an uneven bulging forwards of this cicatricial connective tissue with blood-vessels and round cells. 8. Remains of pigment and sphincter pupillæ muscle adherent to staphyloma. 9. Traces of uvea of iris adherent to staphyloma, which is of considerable thickness opposite this spot. 10. Black masses of pigment from uvea of iris, attached to staphyloma, which is comparatively thin at this part.

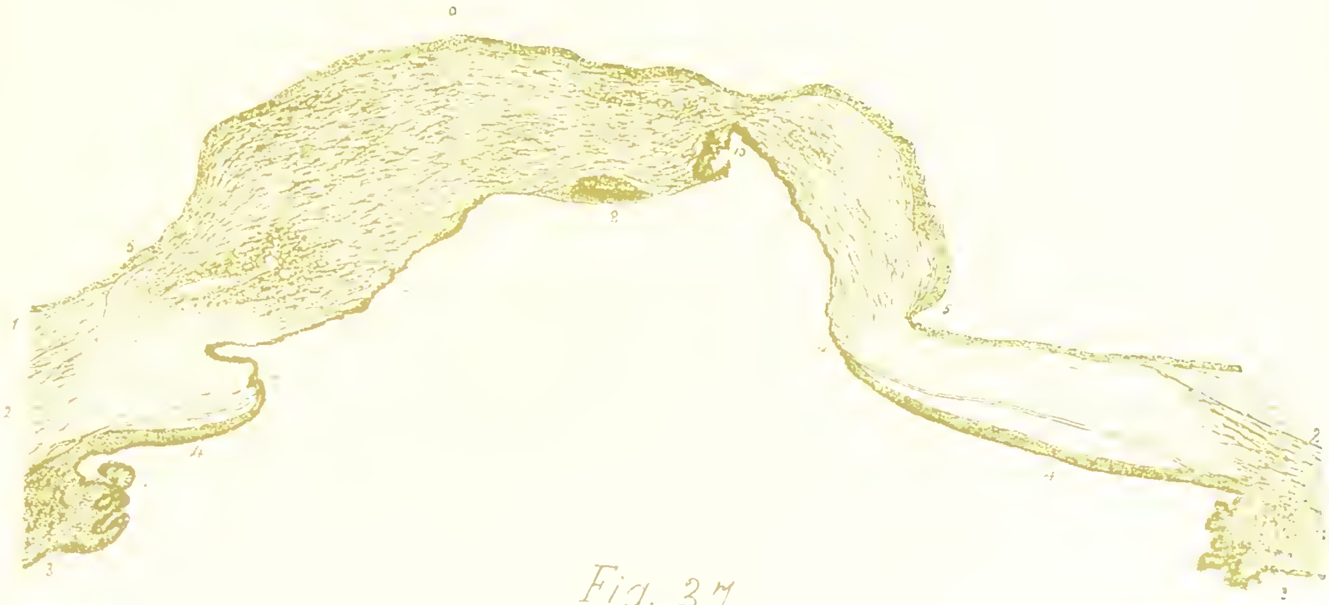


Fig. 37

PLATE XIX.

FIG. 38.—Vertical Section of Corneal Wound.

× 10. Glycerine.

This is from a girl, fifteen years of age, who received a contused wound of the cornea. There was an extensive prolapse of the iris with free hæmorrhage, and the globe was very soft. Inflammation of the iris ensued, and nineteen days after the injury the stump of the collapsed eyeball was removed.

1. Cornea. Near the wound the lamellæ are spread out, and the cornea is thus thickened. Descemet's membrane bounds the posterior wavy outline. 2. Inflammatory exudation, occupying the wide wound. 3. Remains of pigment from iris in the exudation. 4. Anterior epithelium, spreading irregularly over the wound. It is separated from the underlying exudation, probably owing to the hardening of the specimen. Bowman's membrane is interrupted.

FIG. 39.—Vertical Section of Corneal Cicatrix with adherent Iris and Wounded Lens.

× 55. Glycerine.

This is from an eyeball removed eight weeks after a penetrating wound of cornea, iris, and lens.

1. Anterior epithelium. 2. Bowman's membrane, interrupted at wound. 3. Substantia propria. The edges of the lamellæ at the wound are rounded off. 4. Descemet's membrane, interrupted at the wound and wavy. 5. From this point an oblique cicatrix runs through the cornea, composed of dense, opaque, fibrous tissue. It is continued beneath Bowman's membrane to the right and above Descemet's membrane to the left. 6. Iris, infiltrated with inflammatory round cells, and showing remains of pigment. It is adherent to the cicatrix, and to the posterior surface of the cornea at a little distance from this (synechia anterior). 7. Inflammatory exudation inside capsule of lens. 8. Capsule of lens, interrupted at wound. 9. Amorphous coagulated material adherent to posterior surface of capsule.

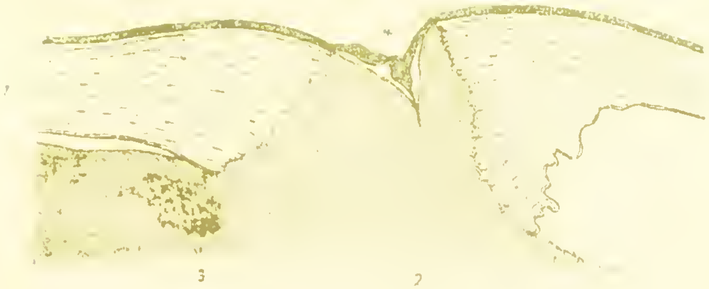


Fig. 38.

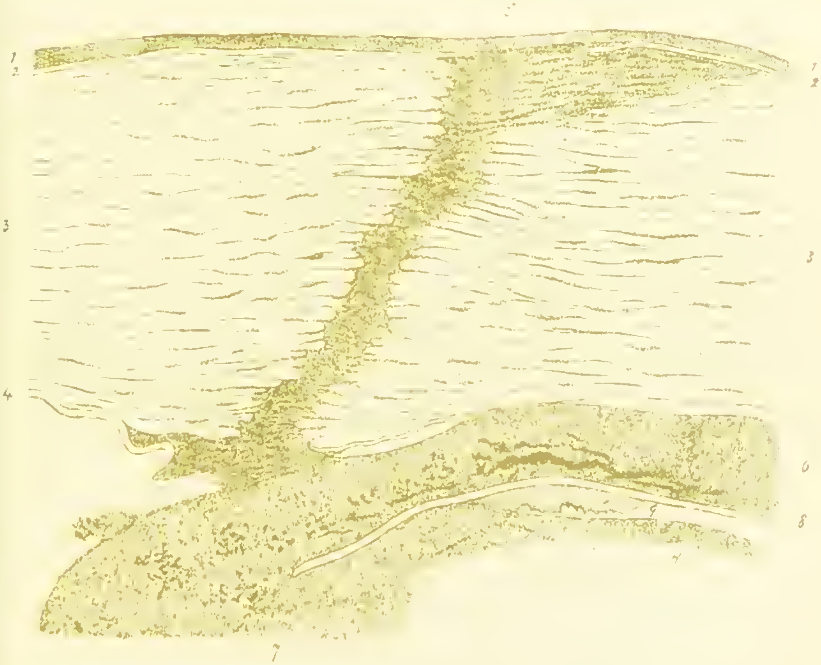


Fig. 39.

Fred Pollock del.   Runciman Glasgow

PLATE XX.

Fig. 40.—Vertical Section of Wound at Margin of Cornea, with Prolapse of Iris.

× 10. Glycerine.

This is from a child, four years of age, who received a penetrating wound at the margin of the cornea four weeks before the enucleation of the eyeball.

1. Cornea, thickened near wound by spreading out of lamellæ. 2. Sclerotic. 3. Conjunctiva. 4. Wound, gaping and occupied by remains of prolapsed and inflamed iris. 5. Remains of iris with pigment.

Fig. 41.—Fatty Débris in Anterior Epithelium over a Corneal Cicatrix.

× 300. Glycerine.

Fig. 42.—Calcareous Deposit in a Corneal Cicatrix.

· 300. Glycerine.

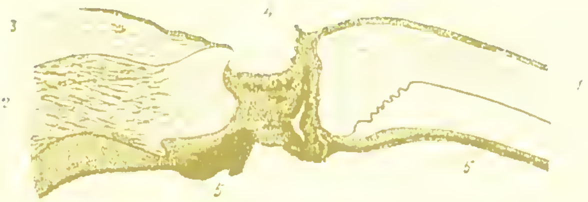


Fig. 40.

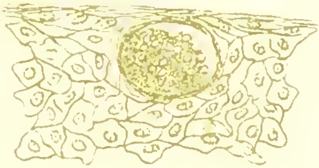


Fig. 41.

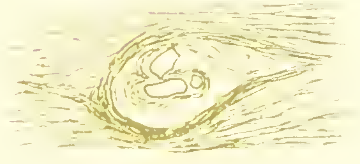


Fig. 42.

OATTS & RUNCMAN ASGOW MP

PLATE XXI.

FIG. 43.—Part of Vertical Section of Corneal Cicatrix.

× 200. Logwood, Dammar.

The cicatrix was very narrow, and ran in the direction from 1 to 1. There is a great increase in the number of the cells, the stained nuclei of which are abundant.

FIG. 44.—Vertical Section of Cornea with Glaucomatous Keratitis, Leucoma, and Débris.

× 45. Logwood, Dammar.

This is from the same case as Fig. 180.

1. Anterior epithelium, thickened irregularly. 2. Dense fibrous tissue (leucoma), with clear masses, blood-vessels, and collections of inflammatory round cells. 3. Substantia propria. 4. Posterior surface. Descemet's membrane is indistinguishable.

FIG. 45.—Meridianal Section of Ciliary Region twenty-eight days after Sclerotomy for Glaucoma. Synechia Anterior. Pigment in Cornea.

× 10. Logwood, Dammar.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Iris, thinned and atrophied. 5. At this point the iris is adherent to the cornea, where the incision was made. Descemet's membrane is interrupted here, and there is a considerable amount of pigment in all the layers of the cornea at this part, and also between the inner layers from this towards the ciliary body. The periphery of the iris is adherent to the cornea from 5 to 6. 6. Anterior part of ciliary processes. 7. Ciliary body, atrophied.

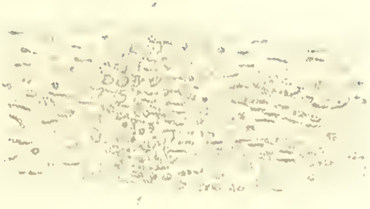


Fig. 43.

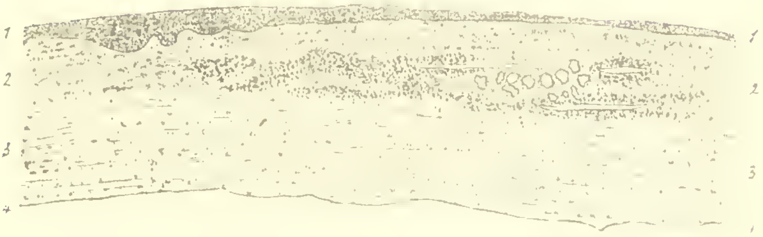


Fig. 44.

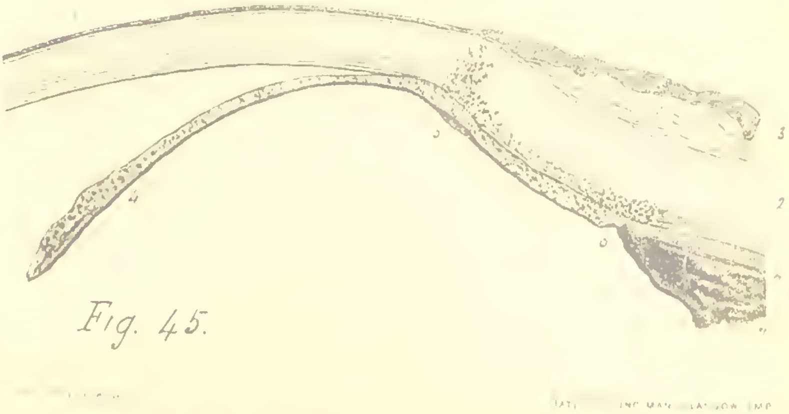


Fig. 45.

[illegible] ING MAN [illegible] GLASGOW IMP

PLATE XXII.

Fig. 46.—**Anterior portion of Eyeball with Wound of Cornea, Cicatrix, Synechiæ, and Traumatic Cataract.**

× 10. Glycerine.

This is from a girl, eleven years of age. The cornea was wounded near the centre, and at the same time the capsule of the lens was injured. Slight prolapse of the iris occurred, and the lens became opaque. This was followed by irido-cyclitis and cicatrization of the wound; and forty-eight days after the injury the eyeball was enucleated.

In addition to the changes drawn in the figure, the shallow anterior chamber was found to contain a little pus; but this dropped out of the sections in the course of preparation.

1. Conjunctiva. 2. Sclerotic. 3. Ciliary body, infiltrated with round cells. 4. Cornea. 5. Wound in cornea, occupied by cicatricial tissue varying in density at different parts, containing pigment and blood-vessels; it is continuous with a mass of similar tissue in place of the lens. 6. Iris, infiltrated with round cells. The pupillary region is thickened, and adherent to the cornea and the cicatrix (synechia anterior). The uveal pigment layer has been detached at various places, and drawn into the inflammatory material. The peripheral portion of the iris is thinned, and bulges forwards. 7. Folded remains of the wounded capsule of the lens. A delicate band of fibres connects this with the pars ciliaris retinæ on the right side. 8. Inflammatory material in the situation of the lens and adjacent vitreous, composed of a fibrous mass with many cells, and some pigment, both free and in cells.

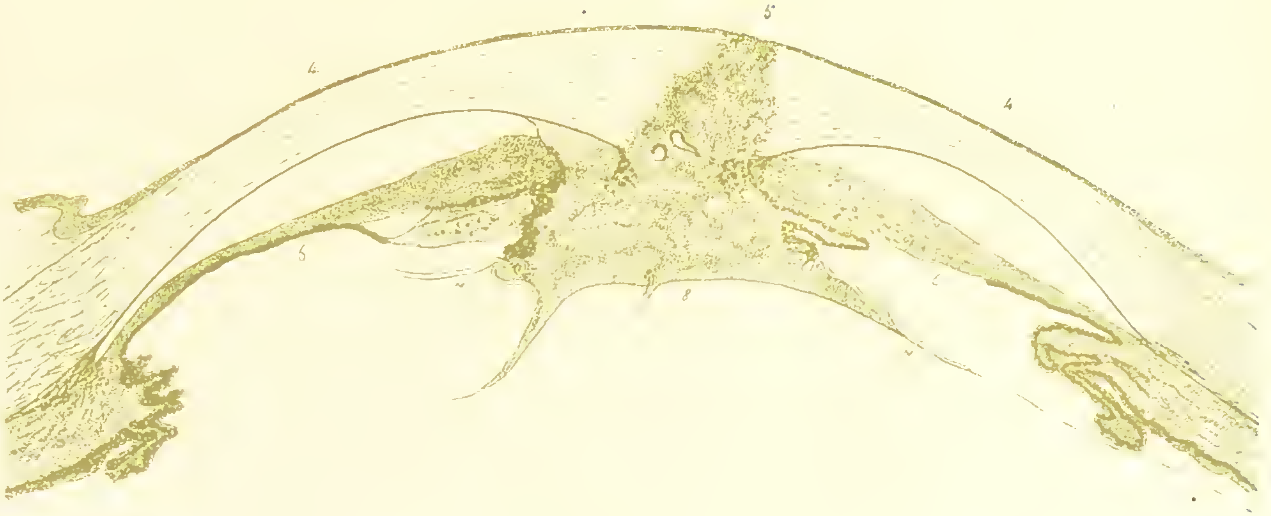


Fig. 46.

Watts & Runciman Glasgow

PLATE XXIII.

Fig. 47.—**Vertical Section of anterior portion of Corneal Cicatrix.**

× 30. Glycerine.

For the history of this case see Fig. 77.

1. Anterior epithelium, irregularly thickened. 2. Bowman's membrane, interrupted and folded at the cicatrix. 3. Substantia propria. 4. Cicatricial tissue. 5. Pigment from iris in the cicatrix. 6. This is in front of the cicatrix. Under a layer of epithelium there is a space containing round cells, pigmented cells, and fibrinous cords. It is bounded posteriorly by epithelium and Bowman's membrane at the sides, and by cicatricial tissue in the middle.

Fig. 48.—**Vertical Section of margin of Corneal Cicatrix with Prolapsed Iris.**

× 30. Glycerine.

1. Anterior epithelium. 2. Bowman's membrane, bending backwards at the cicatrix. 3. Substantia propria. 4. Descemet's membrane. Part of it is rolled up and embedded in the cicatrix. 5. Fibrous tissue in the cornea, continuous with the cicatrix. 6. Iris near prolapsed portion. The uvea is broken up and partly destroyed. 7. Capsule of lens. Part of it is curled up in the posterior portion of the cicatrix. 8. Some fibres of the lens. 9. Granular débris behind the capsule. 10. Cicatricial tissue with pigment from the iris. 11. Cicatricial tissue with part of the capsule of the lens embedded in it. 12. Some denser bands occur here, and a higher power showed these to be blood-vessels filled with corpuscles, with which the anterior portion of the cicatrix was abundantly supplied. 13. Epithelium in front of cicatrix.

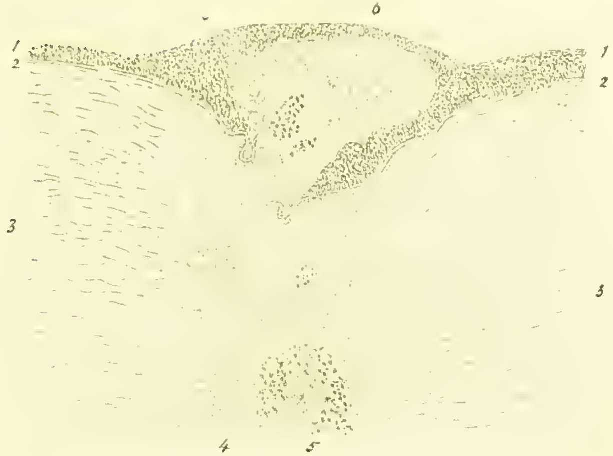


Fig. 47.

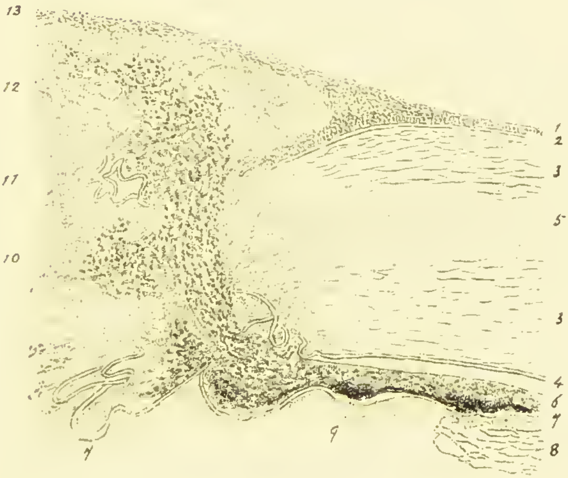


Fig. 48.

C. Fred Pollock, del.

Hatts & Runciman Glasgow, Imp.

PLATE XXIV.

Fig. 49.—Anterior portion of acutely inflamed Stump of Eyeball after Injury.

× 10. Glycerine.

This is from the atrophied stump of the left eye of a man, forty years of age. It was blinded by an injury eleven years before enucleation, and was acutely inflamed at the time of removal.

1. Conjunctiva, with collections of round cells. 2. Sclerotic. 3. Margin of perforation in the cornea, which was contracted, vascular, and suppurating (purulent keratitis). 4. Cornea, infiltrated with inflammatory cells near the part with suppuration. Descemet's membrane is detached, and lies loose behind this. 5. Cornea. 6. Swollen and distorted iris, plugging the opening in the cornea (prolapse). It is crammed with round cells (purulent iritis); and the uvea is much broken up, and separated from its posterior surface. Descemet's membrane is seen intervening between the iris and the inflamed cornea. The anterior chamber is obliterated. 7. In front of this is a portion of the iris, infiltrated with leucocytes; its uvea is partly detached and destroyed, and partly embedded in the inflammatory products behind this. 8. In front of this the iris is normal. Behind it the ciliary processes are much elongated; the pars ciliaris retinæ is increased in thickness and contains many round cells. A similar condition of the ciliary processes is seen on the opposite side. 9. This is behind the ciliary body, which is detached and dragged inwards by the inflammatory membrane. Its inner layers are filled with leucocytes. The distance between the ciliary processes on the opposite sides of the eyeball is decreased. 10. Choroid. The pigment layer is wanting at the right side. 11. In front of this are fibres of the zonula of Zinn, passing inwards from the ciliary body. There is some pigment amongst them. 12. Inflammatory membrane. It is attached in front to folds of Descemet's membrane and the inflamed iris. In this part, which is rich in round cells, the remains of the capsule of the lens are seen folded and curled up. Laterally it is attached to the zonula and the ciliary body, and contains masses of pigment. 13. Posterior part of the inflammatory tissue with fibres and cells and some retinal elements. At the left side it is seen passing backwards to be connected with a newly formed membrane in front of the choroid, in which there was a formation of bone. 14. Collections of inflammatory round cells. 15. Peripheral portion of detached retina, forming a loose network of fibres with abundant nuclei.

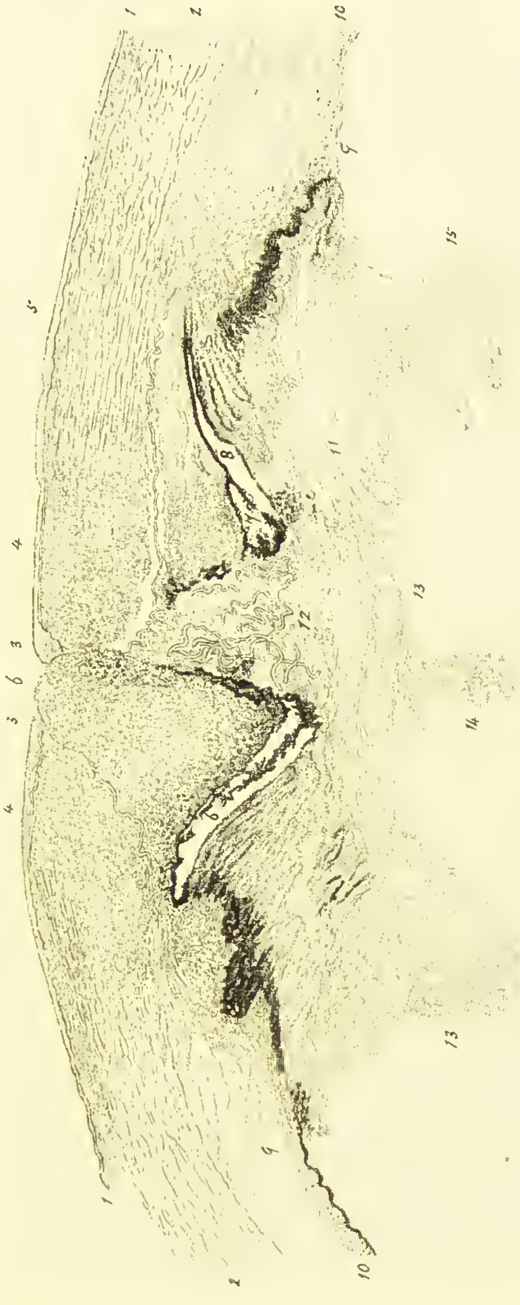


Fig. 49.

C. Fred Pollock, del.
Oatts & Runciman Glasgow, Imp.

PLATE XXV.

FIG. 50.—**Anterior portion of Eyeball with Shrinking after Injury.**

× 10. Glycerine.

This is from the right eye of a man, seventeen years of age. A thin scale of iron passed backwards through the lower and outer part of the cornea, iris, and lens, and lodged in the sclerotic near the optic disc. The accident was followed by loss of lens substance, irido-cyclitis, complete detachment of the retina, and, ultimately, partial shrinking of the globe. Three months after the injury the eyeball was enucleated.

1. Conjunctiva. 2. Sclerotic. 3. Cornea. The anterior epithelium is irregularly thickened, and the posterior surface is uneven. 4. At this part the corneal wound was inflicted. It is covered by a thick layer of epithelium, behind which Bowman's membrane is wanting. 5. Large gap in the cornea, bounded in front by a comparatively thin layer of cicatricial tissue, in which Bowman's membrane is folded up. 6. Choroid. 7. Ciliary body. 8. Inflammatory membrane, resulting from cyclitis. It is chiefly fibrous tissue, rich in cells; pigmented cells and free particles of pigment are scattered throughout it. In front are masses of pigment, which form the only traces of the iris present. 9. Fragment of the capsule of the lens. 10. Remains of retina. 11. At this side all that is left of the ciliary body is the ciliary muscle with a little of the surrounding stroma.

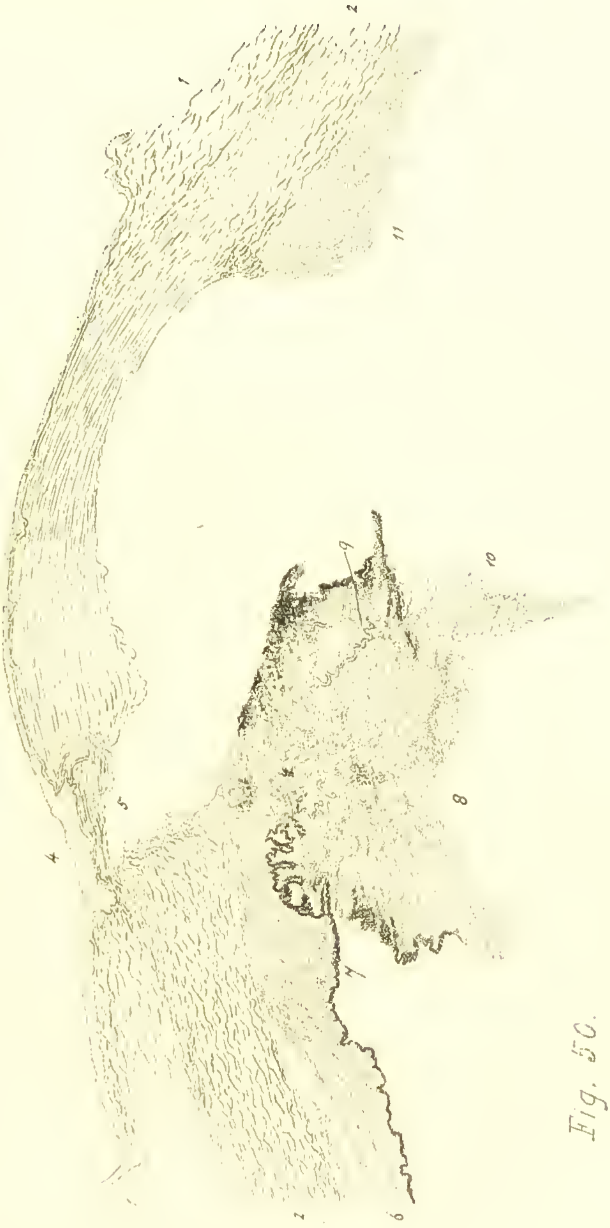


Fig. 50.

Fred Pollock del.
Oatts & Runciman Glasgow, Imp.

PLATE XXVI.

Fig. 51.—**Anterior portion of Eyeball with Corneal Staphyloma and Ulcer, Cataract, and Detachment of Retina and Choroid.**

× 10. Glycerine.

This is from a man, thirty years of age, with complete staphyloma of the cornea, towards the centre of which there was an ulcer. The retina was detached, and passed as a cord forwards from the disc towards the posterior surface of the lens. The choroid was detached by hæmorrhage; its anterior portion is shown in the figure, and posteriorly it was attached to the margin of the disc.

1. Conjunctiva, infiltrated with round cells. 2. Sclerotic. 3. Cornea. It is considerably thinned; behind the anterior epithelium is a layer of round cells with blood-vessels (pannus); and the posterior surface, covered with Descemet's membrane, is uneven. 4. Cornea, with pannus and infiltrated with leucocytes. 5. At this part the cornea is uneven owing to ulceration. The position of the ulcer, in front of the corneal layers, is occupied by cicatricial tissue, covered with epithelium. 6. Between this point and the ulcer the corneal substantia propria was replaced by dense cicatricial tissue (leucoma), covered anteriorly by thickened and uneven epithelium, and united posteriorly to the iris (synechia anterior). Descemet's membrane is wanting. 7. In front of this the altered iris forms a thin layer of varying thickness. It is adherent to the cornea (synechia anterior); and the uvea is much broken up and detached. 8. Space intervening between the iris and the uvea, containing fibrine, round cells, and collections of pigment both free and in cells. 9. Remains of iris, forming little more than a pigmented line behind the cornea. 10. Ciliary body, detached. The ciliary processes are much atrophied. 11. Choroid, detached by extensive sub-choroidal hæmorrhage. It contained some collections of round cells and blood corpuscles. 12. Blood-clot. 13. Capsule of the lens, which is displaced forwards. It is adherent in front to the cornea, and united to the remains of the iris by inflammatory membranes (synechia posterior). 14. Cortical lens fibres. 15. Calcareous deposit in the lens. 16. Traces of the detached retina. 17. Fibrous tissue, with remains of the zonula of Zinn, uniting the capsule of the lens to the surrounding structures. 18. Portion of detached retina, in which indications of the layers can be distinguished. It is adherent anteriorly to the tissue about the lens.

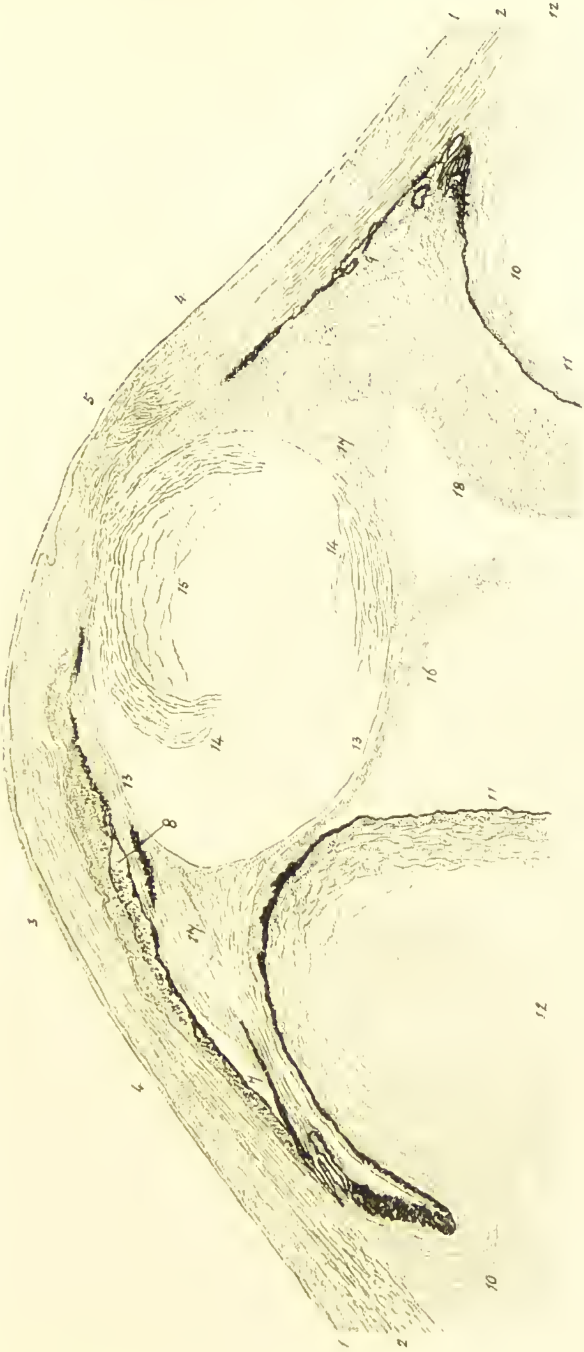


Fig. 51.

C. Fred Pollock, del.

Oatts & Runciman, Glasgow, Imp.

PLATE XXVII.

Fig. 52.—Vertical Section of Sclerotic, Choroid, and Retina.

× 200. Stained, Dammar.

This is from the eyeball of a child, nine months old; 5 millimètres behind the ora serrata.

1. Loose connective tissue outside sclerotic. 2. Sclerotic. 3. Pigmented cells in the inner layers of the sclerotic. 4. Lamina fusca, outside peri-choroidal space. 5. Choroid. 6. Pigmented epithelium, inside lamina vitrea of choroid. 7. Rods and cones of retina. 8. External nuclear layer of retina. 9. Internal nuclear layer. 10. Ganglionic nerve cells and nerve fibre layer. 11. Membrana limitans interna.

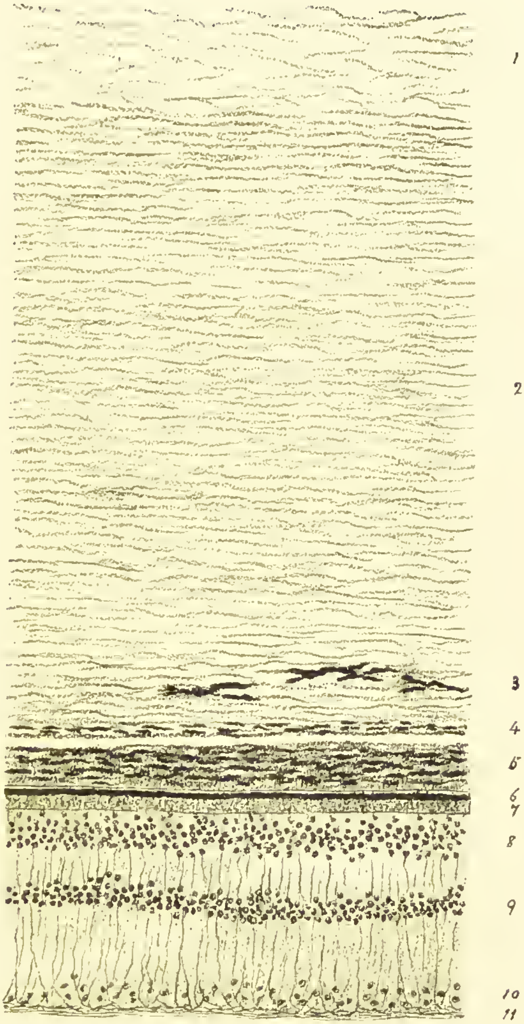


Fig. 52.

G. Fred. Pollock. del
Oatts & Runciman. Glasgow. Imp.

PLATE XXVIII.

Fig. 53.—Vertical Section of Sclerotic, showing Pigmented Cells in Sheath of Blood-vessel and Nerve.

× 45. Glycerine.

1. Lamina fusca, lining internal surface of sclerotic. 2. Sclerotic. 3. Blood-vessel. 4. Nerve, cut obliquely.

Fig. 54.—Oblique view of Lamina Fusca.

× 200. Dammar.

1. Internal surface of sclerotic, seen obliquely, and showing pigmented cells.

Fig. 55.—Two groups of Branched Pigmented Cells from Lamina Fusca.

× 300. Glycerine.

Fig. 56.—Layer of Epithelioid Cells lining Internal Surface of Sclerotic.

× 300. Silver, Glycerine.

This is from an albino rabbit. The intercellular substance is stained by the silver.

Fig. 57.—Layer of Epithelioid Cells covering the Surface of the Scleral portion of the Capsule of Tenon.

× 300. Silver, Glycerine.

The silver has stained the intercellular substance and also some of the cells in different degrees.

Pl. XXVIII

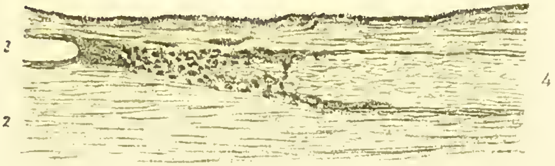


Fig. 53.

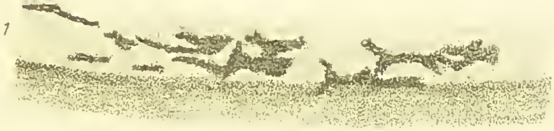


Fig. 54.

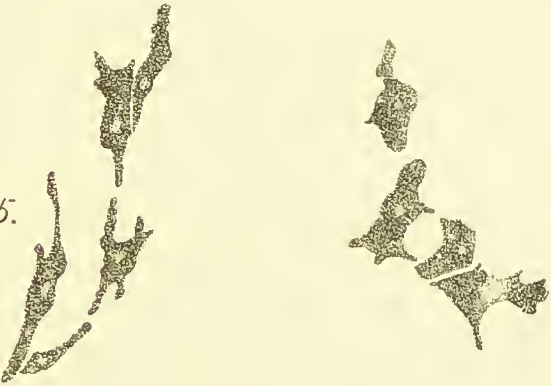


Fig. 55.

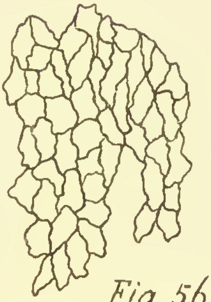


Fig. 56.

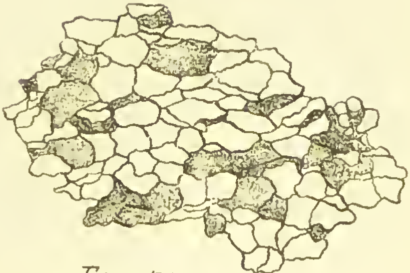


Fig. 57.

C Fred Pollock del   Watts & Runciman, Glasgow, Imp.

PLATE XXIX.

FIG. 58.—Portion of Vertical Section of Sclerotic with Sclerotitis.

× 300. Glycerine.

1. Bands of scleral fibres. 2. Inflammatory round cells between the bundles of white fibrous tissue.

FIG. 59.—Vertical Section of Thickened Sclerotic.

× 6. Dammar.

This is from the stump of an eyeball with chronic atrophy. The contracted cornea was converted into a vascular fibrous mass; the iris was quite destroyed; and a loose fibrous tissue with pigmented cells occupied the position of the ciliary body. The remains of the choroid and retina were massed together, as a fibrous pigmented structure with spicules of bone, inside the shrunken globe.

1. External surface. 2. Internal surface, with wavy folds. 3. Anterior portion, of normal thickness. 4. Posterior portion, greatly thickened.

FIG. 60.—Vertical Section of Cicatrix of Sclerotic, Choroid, and Retina.

× 20. Dammar.

This is from a man whose right eye received a blow, resulting in rupture of the sclerotic at the anterior part of the inner side. Intra-ocular hæmorrhage was followed by cyclitis and ultimate softening of the globe; and forty-three days after the accident the eyeball was removed.

1. Sclerotic. 2. Choroid, interrupted at the cicatrix. 3. Retina, detached, folded, and adherent to the cicatrix. 4. Cicatricial tissue running obliquely through the sclerotic. 5. Remains of choroid and retina in cicatricial fibrous tissue.

Pl.XXIX

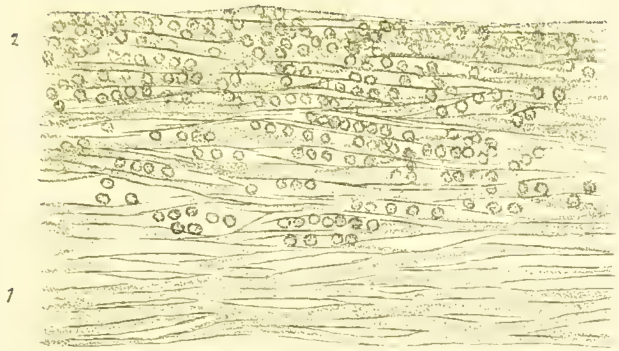
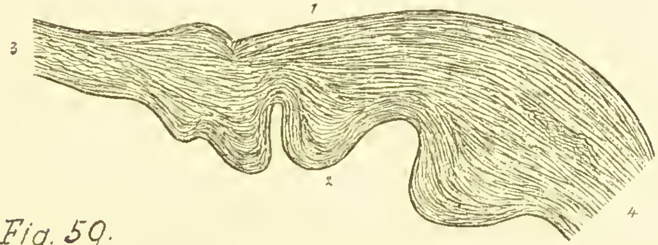


Fig. 58.



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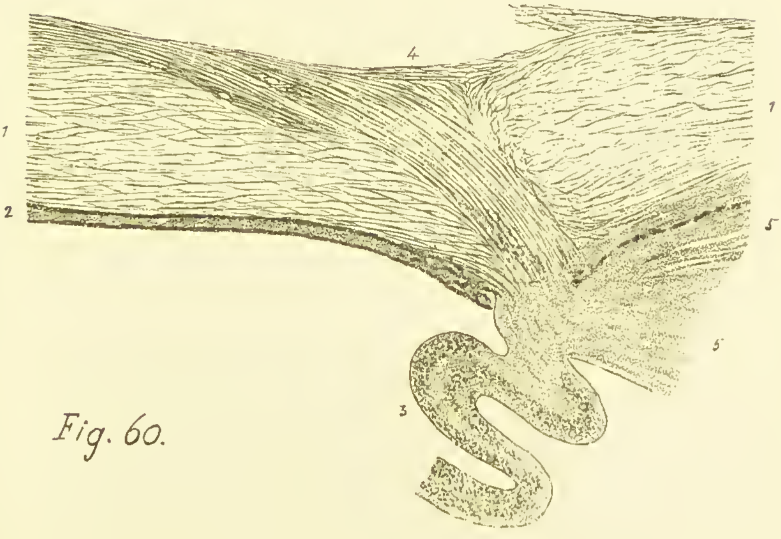

Fig. 60.

C Fred Pollock, del.

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PLATE XXX.

Fig. 61.—**Outlines of Meridianal Sections of Iris.**

× 12. Glycerine.

These are all from adults. I. and II. are from the same eye; III. and IV. are from different eyes.

1. Anterior surface. The outline has large waves. 2. Uvea. The posterior surface has many small prominences in I., II., and IV.; the pigment layer is continued round the pupillary edge in I., II., and III. 3. Ciliary margin, or root, of iris. 4. Pupillary margin. The transverse section of the sphincter pupillæ muscle appears as a rod of variable shape and size.

Fig. 62.—**Epithelioid Cells covering Anterior Surface of the Iris of an Albino Rabbit.**

× 300. Silver, Glycerine.

The intercellular substance is stained by the silver.

Pl.XXX

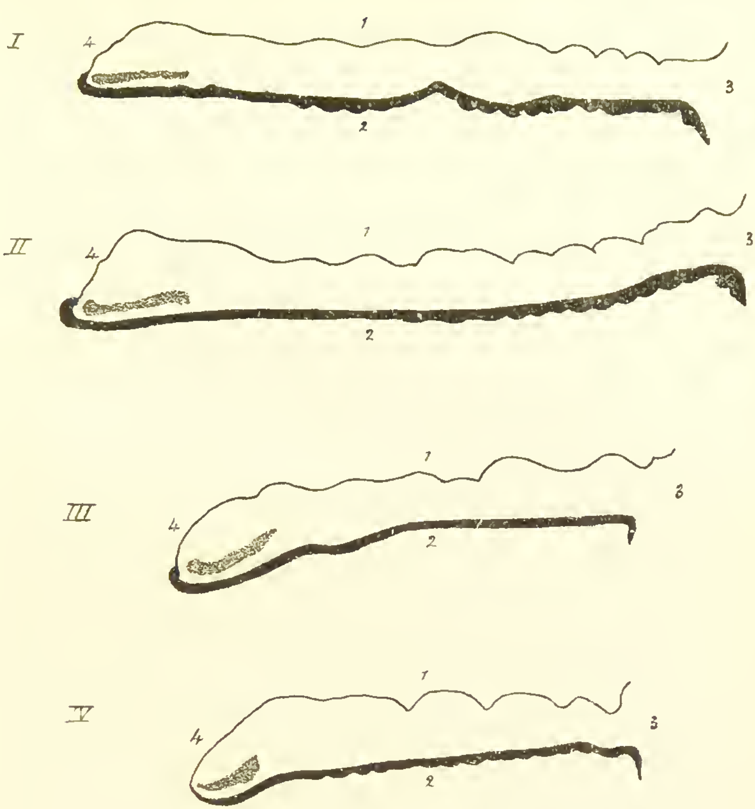

Fig. 61.

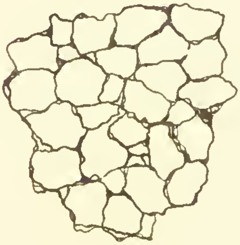

Fig. 62.

C Fred Pollock, del.

Oatts & Runciman Glasgow, Imp.

PLATE XXXI.

Fig. 63.—Vertical Section of Iris.

× 300. Glycerine.

This is from a fair person with "blue eyes."

1. Anterior surface, rich in cells. 2. Stroma, with many branched and round granular cells and fibres of connective tissue. The fibrous tissue is more abundant towards the posterior surface. Two pigmented cells occur about the centre of the figure, and a small collection of pigment is seen nearer the posterior surface; a cross section of a small blood-vessel is present towards the lower corner on the left side. 3. A nerve. 4. Layer of radiating fibres. 5. Uvea or pigment layer.

Fig. 64.—Isolated Branched Cells from the posterior part of the Iris.

× 300. Glycerine.

The processes of two of them unite.

Fig. 65.—Portion of Posterior Surface of Iris.

× 300. Stained, Glycerine.

The uvea has been brushed off; a branched cell of the stroma is seen covered by the layer of radiating fibres with their nuclei.

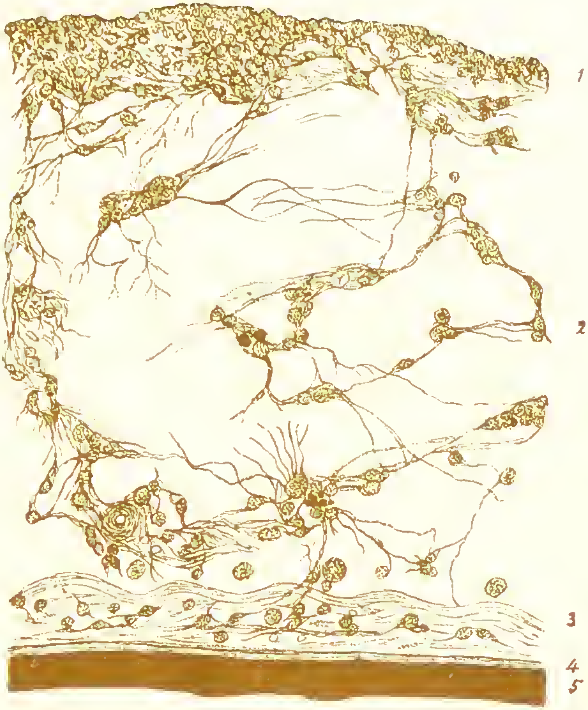

Fig. 63.

Fig. 64.

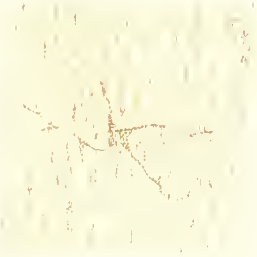

Fig. 65.

C Fred Pollock del

Datts & Runciman Glasgow MP

PLATE XXXII.

Fig. 66.—**Vertical Section of Iris of Negro.**

× 300. Glycerine.

1. Anterior surface; individual cells cannot be distinguished. 2. Stroma, with large branched cells filled with brown pigment, pigmented round cells, unpigmented round cells, and connective-tissue fibres. Some of the pigmented masses, which appear as round cells, may be transverse sections of branched cells or of their processes. 3. Uvea.

Fig. 67.—**Anterior Surface of Iris.**

× 30. Glycerine.

The uvea has been brushed off, and only the inner two-thirds of the breadth of the iris are seen.

1. Pupillary edge. 2. Region of sphincter pupillæ muscle, in which little can be distinguished owing to the density of the tissue and the presence of pigment. 3. Bundles of stroma, radiating irregularly from the pupil. An indication of their continuation over the sphincter can be made out here and there. The peripheral third of the iris, which is not drawn, was similar in appearance to the lower margin of the figure.

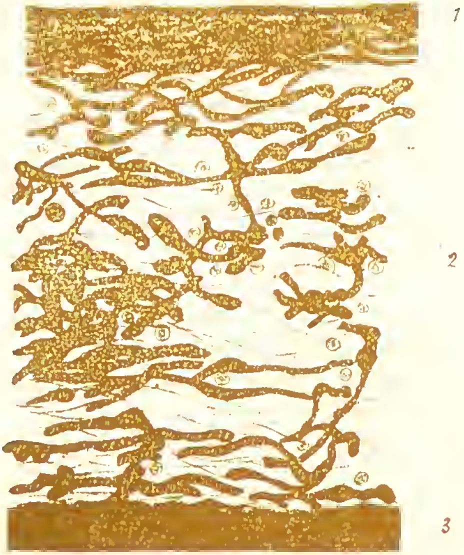

Fig. 66.

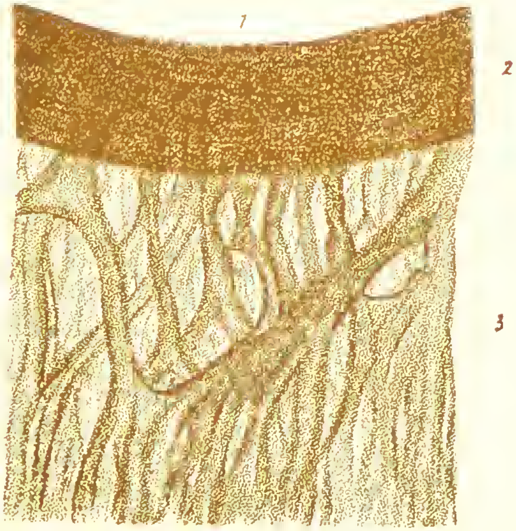

Fig. 67.

C. Fred. Pollock, del.

Oatts & Runciman, Glasgow, Imp.

PLATE XXXIII.

Fig. 68.—Vertical Section of anterior layer of Iris with Iritis.

× 300. Glycerine.

1. Large granular cells on surface of iris; one has two nuclei and a constriction about the middle; others are attached by a slender pedicle. 2. Anterior layer of iris, with inflammatory round cells.

Fig. 69.—Vertical Section of anterior layer of Iris in Purulent Iritis with Hypopyon.

× 300. Glycerine.

For the history of the case see Fig. 146.

1. Anterior layer of iris, with inflammatory round cells. 2. Adherent material in anterior chamber, composed of thin strings of fibrine forming an irregular network, round cells, pus cells, and a small collection of pigment.

Fig. 70.—Vertical Section of posterior layer of Iris with Purulent Iritis.

× 300. Glycerine.

1. Muscular fibres from sphincter pupillæ. 2. Closely packed infiltration of round cells and fibrinous coagulum. 3. Uveal pigment, breaking up into masses and free granules.

Fig. 71.—Vertical Section of posterior layer of Iris in Iritis with Synechia Posterior and detachment of Uvea.

× 300. Glycerine.

This is from the same case as Fig. 51.

1. Posterior layer of stroma of iris, with inflammatory round cells and collections of pigment. The layer of radiating fibres cannot be distinguished. 2. Uvea, separated from the stroma, and irregular. 3. Intervening space, containing granular material, strings of fibrine, inflammatory round cells, large round granular cells, clumps of pigment, and large cells with clear walls and brownish granules of considerable size. 4. Layer of inflammatory exudation behind uvea.

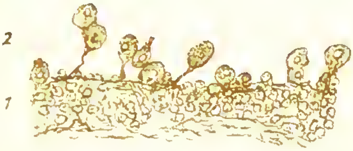

Fig. 68.

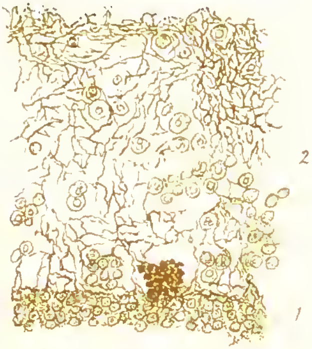

Fig. 69.

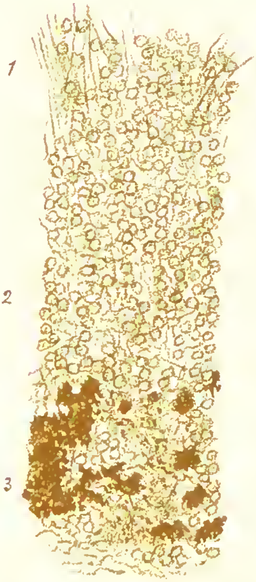

Fig. 70.

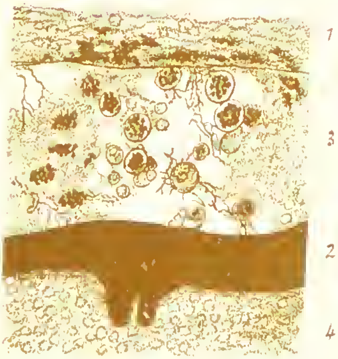

Fig. 71.

C. Fred Pollock, del.

Oatts & Runciman Glasgow, Imp.

PLATE XXXIV.

Fig. 72.—Vertical Section of posterior layer of Iris in Iritis with detached Uvea, Synechia Posterior, and Wound of Lens.

× 300. Glycerine.

This is from the same case as Fig. 77.

1. Posterior layer of iris, with inflammatory round cells and small collections of pigment. 2. Uvea, detached and of unequal thickness. 3. Capsule of lens. 4. Granular coagulated material, with more or less clear vesicles and knobs of various sizes, between the stroma of the iris and the uvea. 5. Newly formed tissue uniting uvea to capsule of lens, formed of fibrous tissue, round cells of different sizes, pigmented round cells, large cells with clear walls and brownish granules, free particles of pigment in small accumulations, and some granular amorphous substance. 6. Inflammatory products inside capsule of lens, composed of round cells of various sizes and many fibres, along with granular substance.

Fig. 73.—Meridianal Section of Ciliary Region in Irido-cyclitis with Synechia Posterior at the Pupil.

× 10. Glycerine.

1. Cornea. 2. Conjunctiva. 3. Sclerotic. 4. Ciliary body. 5. Iris, bulged forwards. The pupillary edge is adherent to the capsule of the lens; and the pupil was funnel-shaped, owing to the protrusion of the iris. 6. Capsule of lens.

Pl.XXXIV

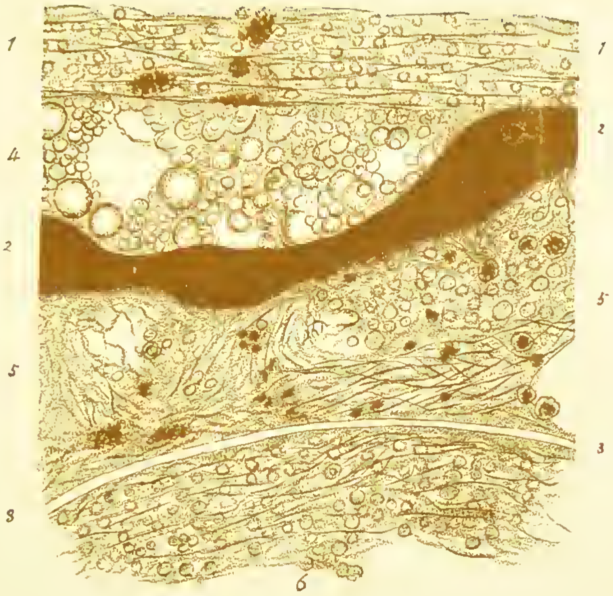

Fig. 72.

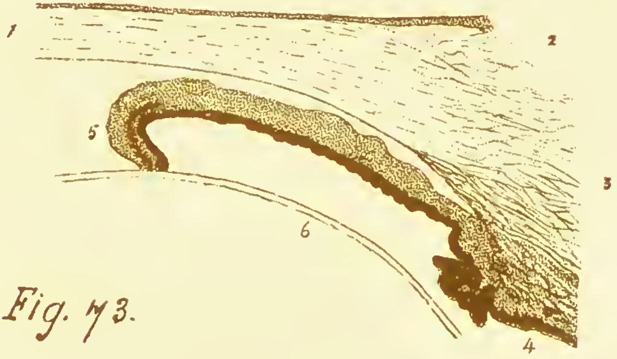

Fig. 73.

C. Fred Pollock, del.
Oatts & Runciman, Glasgow, Imp.

PLATE XXXV.

Fig. 74.—Vertical Section of Cornea, Iris, and Lens in Traumatic Iritis, with Pupillary Membrane and Synechia Posterior.

× 30. Glycerine.

1. Anterior epithelium of cornea. 2. Bowman's membrane. 3. Substantia propria of cornea. 4. Coagulated fibrine in anterior chamber. 5. Pupillary portion of iris. The contracted pupil is occupied by a layer of fibrous tissue, which was attached all round to the iris (occlusion). 6. Capsule of lens, to which the iris is adherent (synechia posterior). 7. Granular material inside capsule of lens. 8. Fibres of lens.

Fig. 75.—Vertical Meridianal Section of Atrophied Iris in Glaucoma.

× 300. Glycerine.

1. Anterior surface. 2. Uvea. The iris is very thin, and the stroma is replaced by fibrous tissue, in which there are a few cells and some granular pigment.

Fig. 76.—Vertical Section of Atrophied Cornea and Iris.

× 10. Glycerine.

This is from a boy, nine years of age, whose right eye was injured by a shot. Partial shrinking of the globe occurred, and the stump was removed fifteen weeks after the accident.

1. Conjunctival tissue. 2. Central portion of atrophied and shrivelled cornea. The surfaces are uneven, and the laminæ are no longer regularly disposed. Towards the margin the normal arrangement is partly retained. 3. Sclerotic. 4. Iris, represented by a thin fibrous membrane, stretching across behind the cornea, and attached at the corneo-scleral junction.

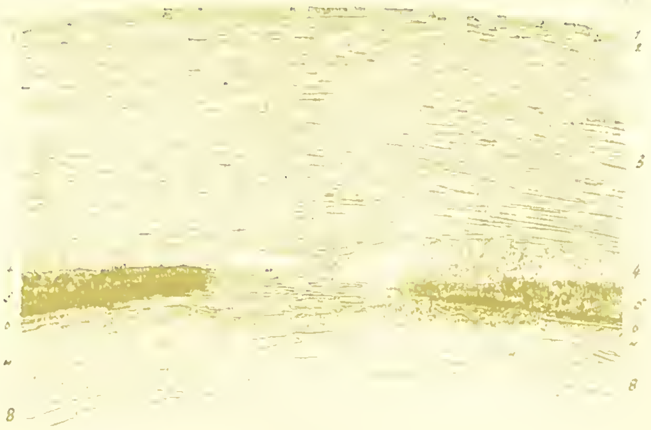

Fig. 74.

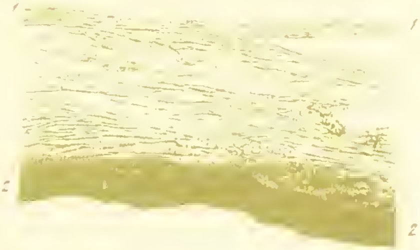

Fig. 75.

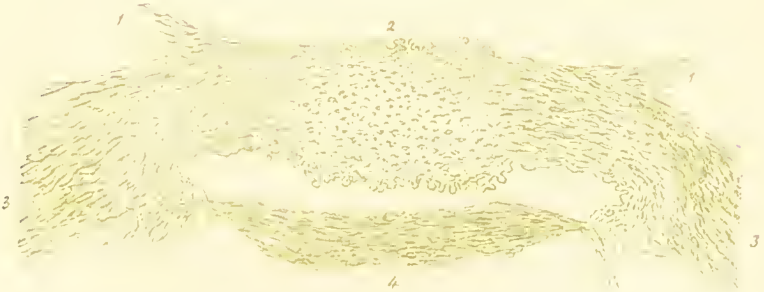

Fig. 76

Fred. Pollock del. Oatts & Runciman Glasgow, lith.

PLATE XXXVI.

FIG. 77.—Anterior portion of Eyeball with Wound of Cornea, Iris, and Lens.

× 10. Glycerine.

This is from a man, nineteen years of age, who received a wound at the margin of the left cornea fifty-four days before the eyeball was enucleated. The injury was followed by atrophy and softening. The condition of the anterior segment is shown in this figure, and the parts about the disc in Fig. 174.

1. Conjunctiva. 2. Sclerotic. 3. Cornea, greatly thickened, especially towards the wound. 4. At this spot the anterior corneal layers are replaced by fibrous tissue (leucoma), apparently indicating the position of an ulcer, which has healed. 5. The cornea is dragged backwards in this region, where the wound passes through. The cicatrix contains pigment from the iris, and is continuous with some fibrous tissue, occupying the whole thickness of the cornea nearer the ciliary region, the result of local keratitis. 6. Iris. The periphery is pressed against the ligamentum pectinatum, the spaces in which are, however, quite open. The pupillary margin is adherent to the cornea at the cicatrix (synechia anterior). The uvea is much broken up, and lies as large masses of pigmented cells in the inflammatory exudation behind the iris; towards the periphery, spaces occur between the stroma of the iris and the uvea, in which there is granular coagulated material. Nothing can be seen of the iris at the opposite side except some scattered pigment. 7. Ciliary body, detached and dragged inwards. It is infiltrated with round cells, which are specially numerous in the inner layers (cyclitis). The distance between the ciliary body on the opposite sides of the eyeball is diminished. 8. Choroid, infiltrated with round cells (choroiditis), and detached. 9. Fibrinous coagulum, in the form of strings and vesicles, among the loose tissue between the choroid and the sclerotic. 10. Portion of capsule of lens, with some cortical fibres of the wounded lens. 11. Peripheral part of the retina, detached, and adherent to the cyclitic membrane. 12. Blood-clot. It is becoming organized, where it is continuous with the inflammatory exudation in front. 13. Delicate fibrous tissue, with many cells and containing traces of the zonula. 14. Inflammatory exudation behind iris, with remains of capsule of lens, masses of detached uvea, scattered particles of pigment, cells from the iris, and a considerable amount of blood-clot. 15. Some retinal elements.

Pl.XXXVI.

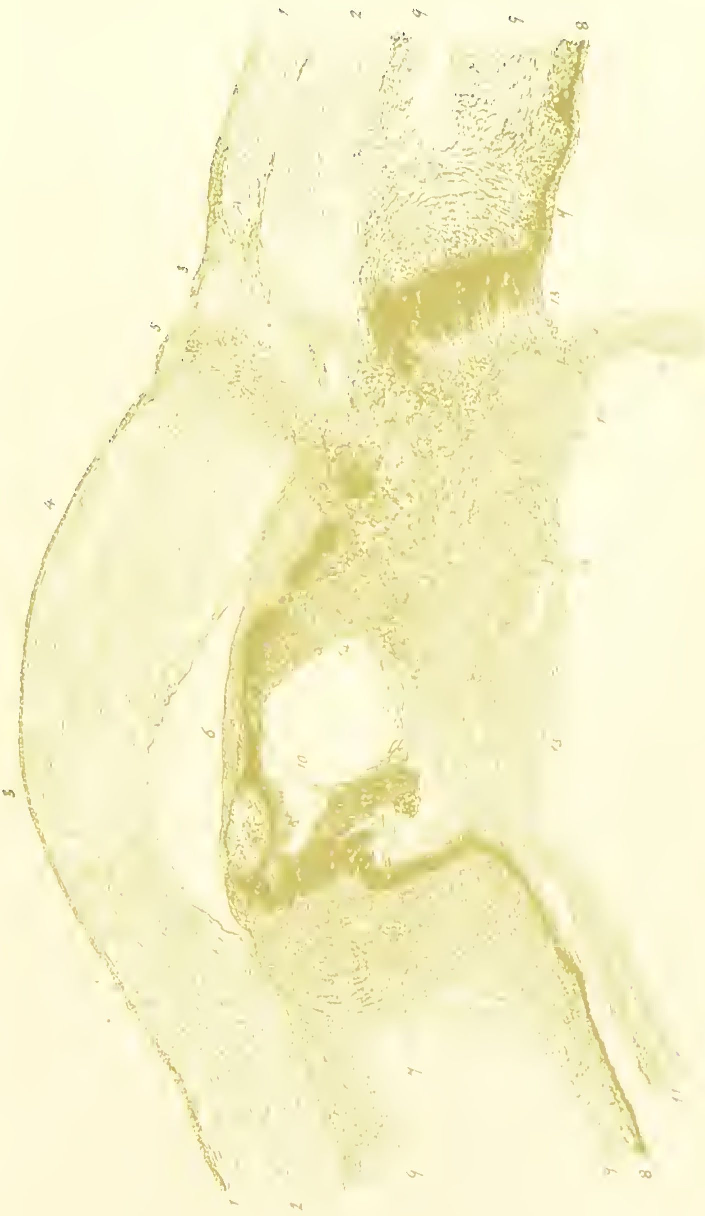

Fig. 74.

C. Fred Po[illegible] [illegible]

[illegible]atts & Runciman [illegible]lasgow [illegible]

PLATE XXXVII.

Fig. 78.—Internal Surface of Choroid, covered with Pigmented Epithelium.

× 10. Glycerine.

This is from a person with fair hair. The collections of pigment in the stroma between the blood-vessels are seen as darker areas.

Fig. 79.—Internal Surface of Choroid without Pigmented Epithelium.

× 10. Glycerine.

This is from a person with dark hair. The pigmented epithelium has been brushed off; and the distribution of the pigment in the stroma is very distinct.

Fig. 80.—Vertical Section of Choroid.

× 300. Glycerine.

This is from the fundus, at a short distance from the optic disc.

1. Pigmented epithelium on inner surface. 2. Lamina vitrea. 3. Membrana chorio-capillaris. 4. Stroma, with sections of large empty blood-vessels, fibrous tissue, pigmented corpuscles, and some leucocytes. 5. External surface.

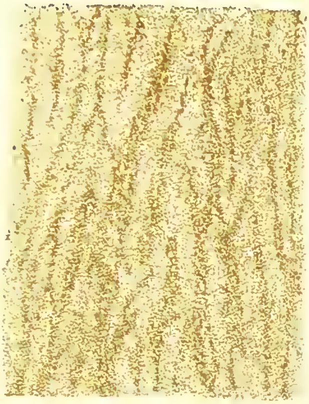

Fig. 78.

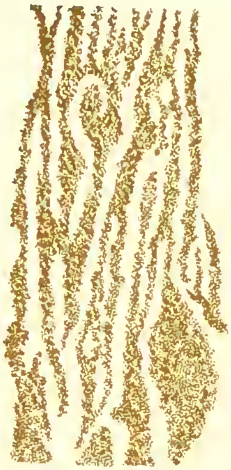

Fig. 79.

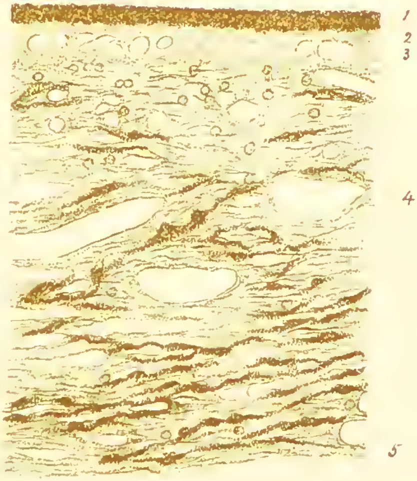

Fig. 80.

Fred Pollock, del.

Gatts & Runciman, Glasgow, lith.

PLATE XXXVIII.

Fig. 81.—**Isolated Branched Pigmented Cells from Stroma of Choroid.**

× 300. Glycerine.

Fig. 82.—**Nerve from Choroid, with Pigment among the Fibres.**

× 300. Glycerine.

Fig. 83.—**Lymphatics of Choroid.**

× 300. Silver, Glycerine.

This is from an albino rabbit.

1. Rootlets of lymphatic capillaries, consisting of spaces left white among areas of connective tissue stained with the silver. 2. Origin of lymphatic vessels, the outlines of the endothelial cells being stained by the silver.

Pl. XXXVIII

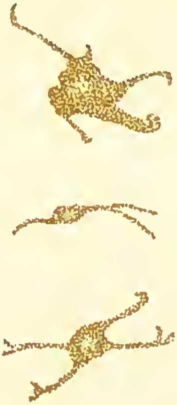
Fig. 81.

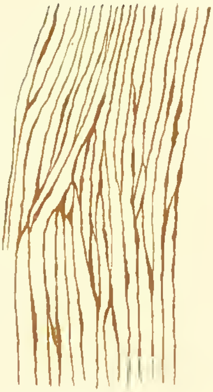
Fig. 82.

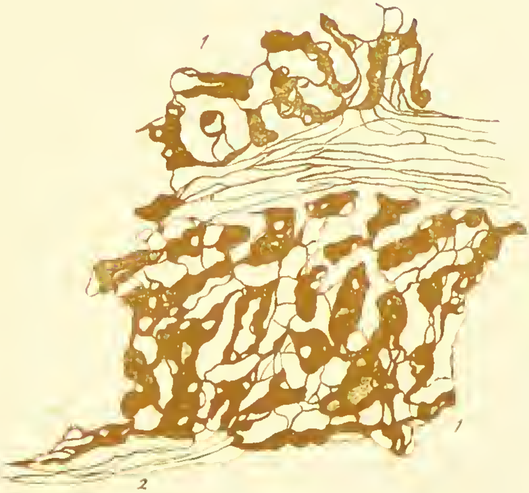

Fig. 83.

Fred Pollock, del.

Carter & Runciman Glasgow. Imp.

PLATE XXXIX.

Fig. 84.—**Endothelium of Choroidal Blood-vessels.**

× 300. Silver, Glycerine.

The intercellular substance is stained by the silver; one or two small openings occur in it.

Fig. 85.—**Epithelioid Cells covering External Surface of Lamina Supra-choroidea.**

× 300. Silver, Glycerine.

The intercellular substance is stained by the silver; the nuclei of some of the cells are well defined.

Fig. 86.—**Group of Branched Pigmented Cells among Fibres from Lamina Supra-choroidea.**

× 300. Glycerine.

Fig. 87.—**Group of large Unbranched Pigmented Cells from Lamina Supra-choroidea.**

× 300. Glycerine.

Fig. 88.—**Pigmented Epithelium.**

× 300. Glycerine.

1. Surface view of cells in group. 2. Isolated cells, seen from the side, showing the clear outer portion.

Fig. 89.—**Pigmented Epithelium.**

× 300. Silver, Glycerine.

This is from a person with fair hair, and the two groups are from the same region of the fundus.

1. Group of larger cells. 2. Group of smaller cells. The intercellular substance is stained by the silver.

Pl. XXXIX

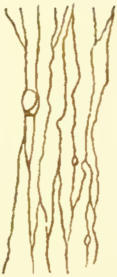

Fig. 84

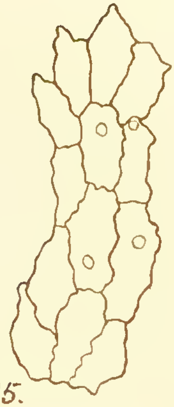

Fig. 85.

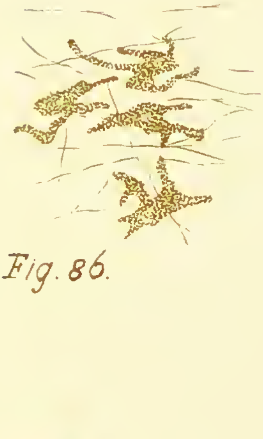

Fig. 86.

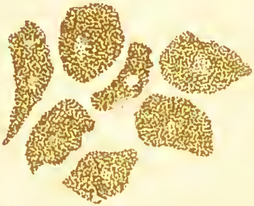

Fig. 87.

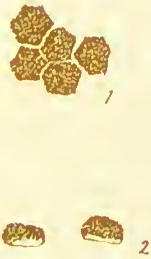

Fig. 88.

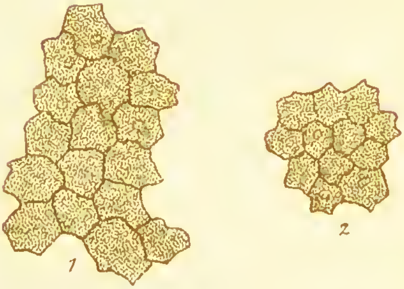

Fig. 89.

C. Fred Pollock, del.

Oatts & Runciman, Glasgow, Imp.

PLATE XL.

Fig. 90.—Internal Surface of Choroid with Hyaline Excrescences of Lamina Vitrea.

× 45. Glycerine.

There is an accumulation of pigment round and over the raised nodules; and the pigmented epithelium is partly atrophied, especially towards the right side of the figure.

Fig. 91.—Vertical Section of Hyaline Excrescences of Choroidal Lamina Vitrea.

× 300. Glycerine.

1. Internal surface of choroid, with large compound excrescences and some smaller simple ones. The pigmented epithelium is wanting; and there is an accumulation of pigment about the nodules. 2. External surface of choroid. The choroid is greatly atrophied and thinned, consisting of fibrous tissue with lines of pigment. 3. Near this there is a blood-vessel with some blood corpuscles.

Fig. 92.—Vertical Section of Hyaline Excrescences in Detached Retina in Cyclitic Membrane.

× 200. Glycerine.

This is from the same case as Fig. 139.

The clear highly refractive masses have delicate and somewhat concentric lines through them. Collections of pigment cover their surfaces at various places; and they are embedded in a loosely fibrous mass, which formed the greatly altered remains of a portion of detached retina embedded in a cyclitic membrane.

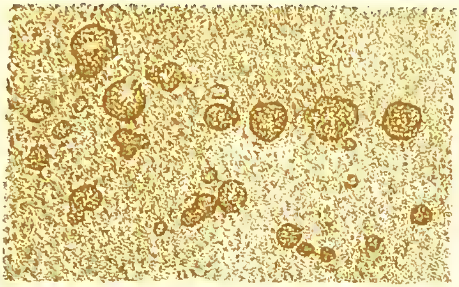

Fig. 90.

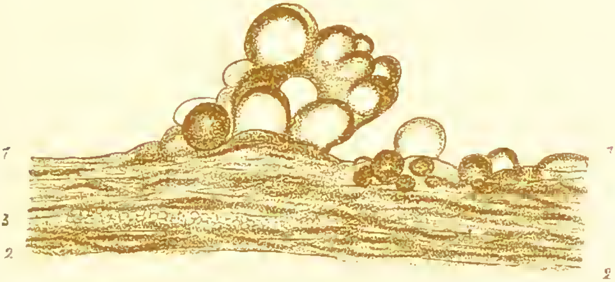

Fig. 91.

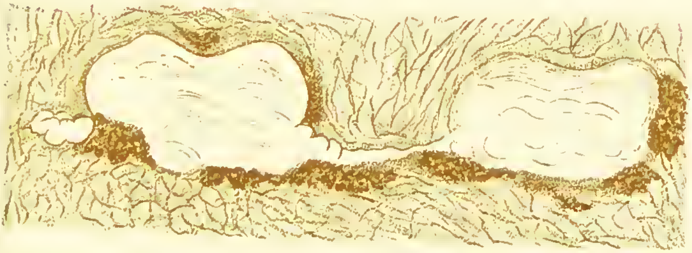

Fig. 92.

C. Fred Pollock, del.
Oatts & Runciman, Glasgow, Imp.

PLATE XLI.

FIG. 93.—Vertical Section of Hyaline Bodies in Altered Choroid.

× 300. Glycerine.

This is from a boy, eleven years of age. Part of the right eyeball was removed when he was five years old, and the remaining stump six years later.

1. Fibrous tissue of atrophied choroid. 2. Masses of pigment, dark in some places and lighter in others. The compound hyaline bodies occupy the centre of the figure, and are composed of clear glassy structures, in which the marking with concentric lines is very distinct.

FIG. 94.—Vertical Section of Choroid with Intra-choroidal Hæmorrhage following injury.

× 30. Glycerine.

1. Internal surface. 2. External surface. 3. Blood-clot, dividing the choroid into two layers.

FIG. 95.—Vertical Section of Periphery of Choroid with Hyperæmia and Œdema.

× 300. Glycerine.

1. Pigmented epithelium. 2. Lamina vitrea and chorio-capillaris. 3. Larger blood-vessels, distended with blood corpuscles. 4. Pigmented cells of stroma. 5. Longitudinal section of nerve on outer surface of choroid. 6. Coagulated granular material, concealing the proper structure of the choroid. The spaces in it are mostly empty blood-vessels.

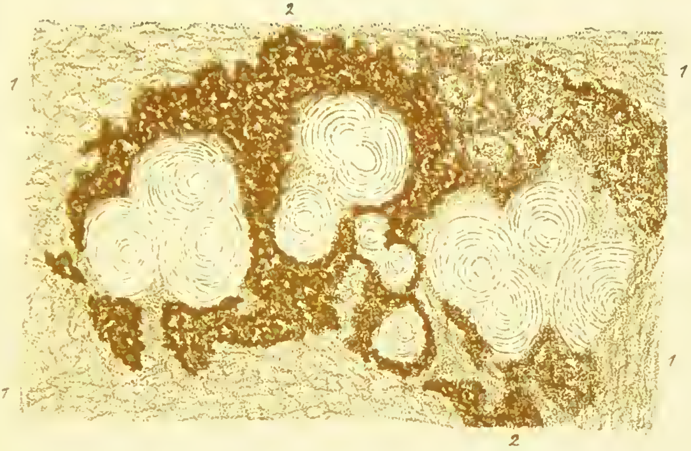

Fig. 93.

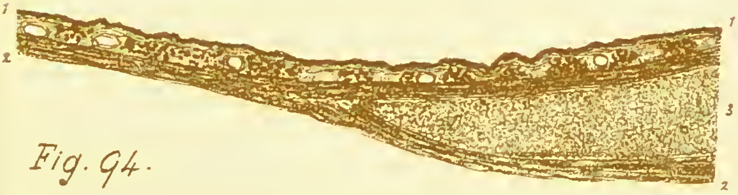

Fig. 94.

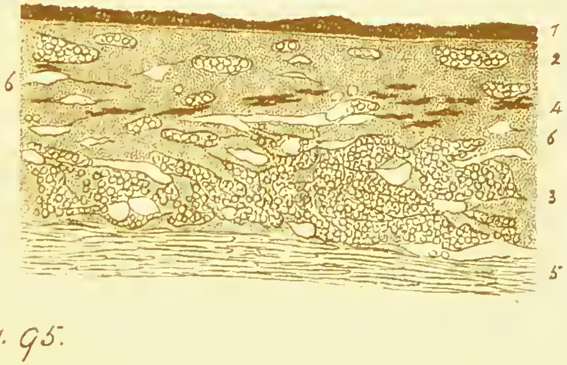

Fig. 95.

C Fred Pollock, del.

Oatts & Runciman, Glasgow, Imp.

PLATE XLII.

Fig. 96.—Vertical Section of Choroid with Œdema.

× 300. Glycerine.

1. Pigmented epithelium. 2. Lamina vitrea and choriocapillaris; the latter is almost indistinguishable. 3. External layer of choroid. 4. Pigmented cells of stroma. 5. Amorphous irregularly granular material, which almost entirely conceals the normal structure of the choroid. There are empty spaces in it, some of them vacuoles in the coagulated substance and others sections of blood-vessels. The thickness of the choroid is considerably increased.

Fig. 97.—Vertical Section of Choroid in Retinitis Albuminurica.

× 300. Glycerine.

1. Pigmented epithelium. 2. Lamina vitrea and choriocapillaris. 3. External layers of choroid, to which the pigmented cells of the stroma are confined in this case. 4. Near this there is an area occupied by coagulated granular material, in which are small spaces. Transverse sections of two arteries are seen, with thickened, transparent, and highly refractive walls. Between them there are some inflammatory round cells. The choroid is comparatively thin.

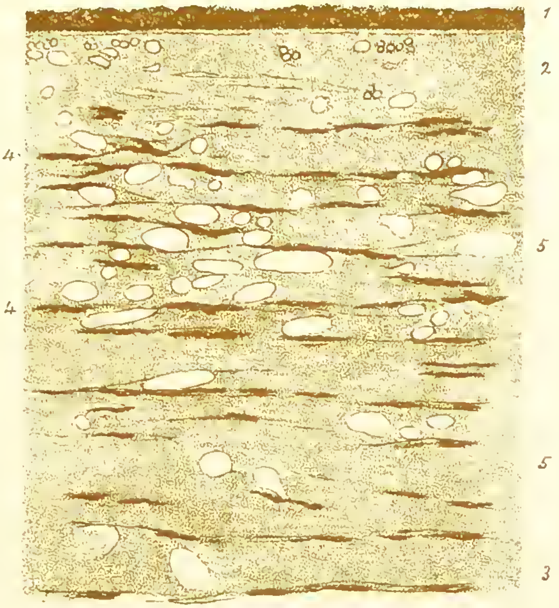

Fig. 96.

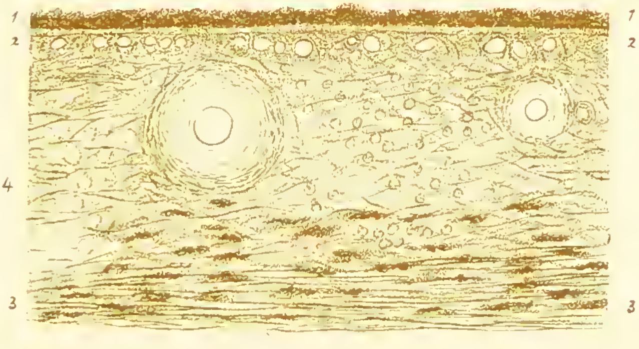

Fig. 97.

C Fred Pollock del. Gatts & Runciman, Glasgow, Imp.

PLATE XLIII.

Fig. 98.—Vertical Section of Choroid with Choroiditis.

× 200. Glycerine.

1. Pigmented epithelium. 2. The pigment layer is absent here. 3. Chorio-capillaris and lamina vitrea. 4. Outer layers, with coagulated granular material, in which there are lacunæ and pigmented cells. 5. Normal choroidal tissue. 6. Very wide vessels, filled with blood corpuscles. 7. Local infiltration of inflammatory round cells. To the left side of this are sections of empty blood-vessels.

Fig. 99.—Small part of Section of Choroid with Choroiditis and Intra-choroidal Hæmorrhage.

× 300. Glycerine.

1. Fibrous tissue. 2. Branched pigmented cell of stroma. 3. Large roundish cells, with clear walls and containing brownish granules.

Fig. 100.—Fatty Cells in Choroid.

× 300. Glycerine.

This is from a case of intra-ocular round-celled sarcoma.

1. Fibrous tissue. 2. Pigmented cells of stroma, breaking up, and surrounded with free particles of pigment and fatty granules. 3. Cells filled with fatty granules. 4. Cells distended with fatty globules Some separate molecules of fat lie near them.

Pl. X

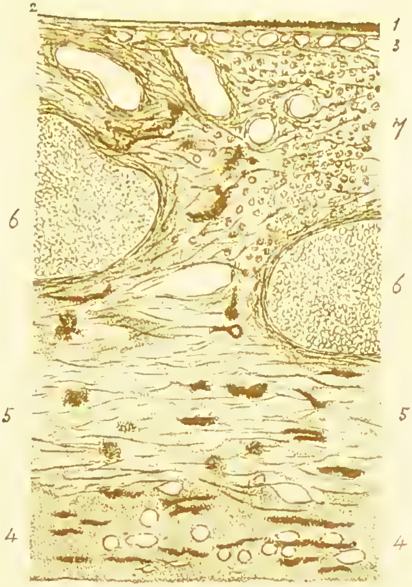

Fig. 98.

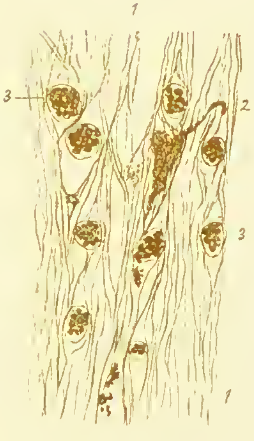

Fig. 99.

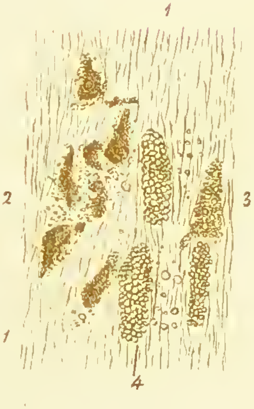

Fig. 100.

C Fred Pollock del
Oatts & Runciman, Glasgow. Imp

PLATE XLIV.

Fig. 101.—Vertical Section of Choroid with Purulent Choroiditis.

× 45. Glycerine.

This is from an eye enucleated five weeks after an injury.

1. Pigmented epithelium. 2. Outer layers. The thickness of the choroid is greatly increased, owing to a dense infiltration with round cells. The pigmented cells of the stroma are intact; and sections of blood-vessels occur here and there, one being filled with blood-clot.

Fig. 102.—Vertical Section of inner layers of Choroid with Purulent Choroiditis.

× 300. Glycerine.

This is a portion of Fig. 101 more highly magnified.

1. Pigmented epithelium, thicker than usual. 2. Clear outer portion of the pigmented cells, in which the nuclei are very distinct. 3. Lamina vitrea. 4. Chorio-capillaris. 5. Choroidal tissue, crammed with round cells, among which only the pigmented corpuscles of the normal stroma can be distinguished.

Fig. 103.—Vertical Section of inner layers of Choroid with Purulent Choroiditis.

× 300. Glycerine.

1. Granular coagulated material lying on the internal surface of the choroid, with lacunæ. 2. Mass of pigment in place of pigmented epithelium. 3. Lamina vitrea. 4. Dense infiltration of round cells. 5. Place at which the inflammatory exudation has spread through the internal layers of the choroid.

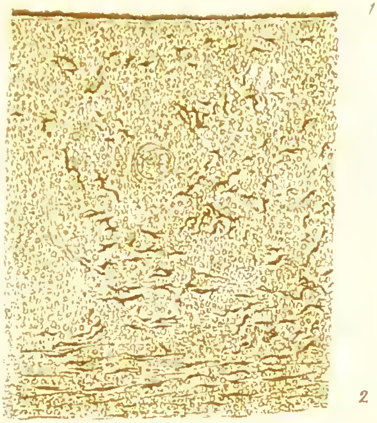

Fig. 101.

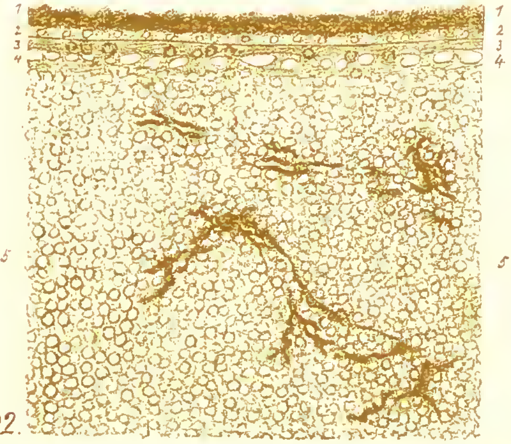

Fig. 102.

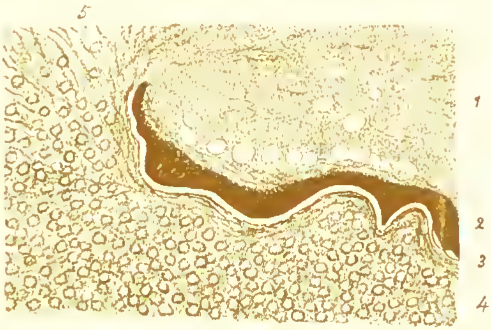

Fig. 103.

J. Fred Pollock del. Oatts & Runciman Glasgow Imp.

PLATE XLV.

Fig. 104.—Vertical Section of Choroid with Formation of Bone.

× 30. Glycerine.

This is from the same case as Fig. 49.

1. External surface of choroid. 2. Fibrous tissue forming membrane on internal surface of choroid. There is no trace of the pigmented epithelium. 3. Bone, with irregular spaces, some of which are Haversian canals with the ordinary concentric arrangement of the lacunæ round them, while others are occupied by granular and fibrous material.

Fig. 105.—Longitudinal Section of Entrance of Optic Nerve; Bone in Choroid, Disc excavated, Retina detached.

× 30. Glycerine.

This is from the left eye of a woman with advanced glaucoma. The margin of the cornea was opaque and vascular, and had a staphylomatous bulging. The lens was opaque and shrunken; and the retina was attached only at the optic disc and the ora serrata. This figure shows the condition of the disc, and Fig. 161 represents the ciliary region.

1. Bundles of nerve fibres. 2. Inner sheath of optic nerve. 3. Outer sheath. 4. Sclerotic. 5. Choroid, with excess of fibrous tissue. The pigmented epithelium is wanting. 6. Beneath this is seen a section of bone, which formed a ring round the disc, embedded in the choroid. 7. Disc, with glaucomatous excavation. 8. Posterior portion of retina, attached to the floor and margin of the disc. It is simply a fibrous cord.

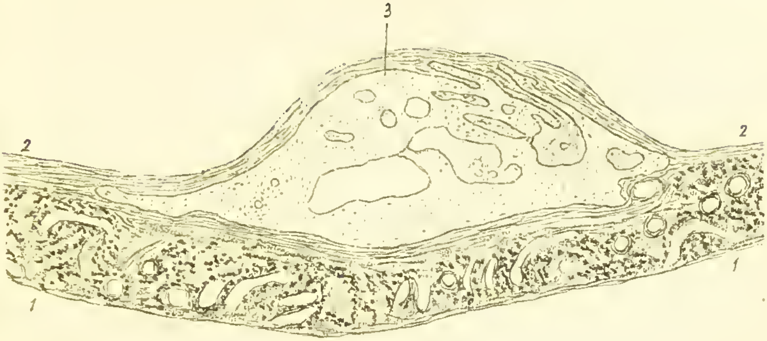

Fig. 104.

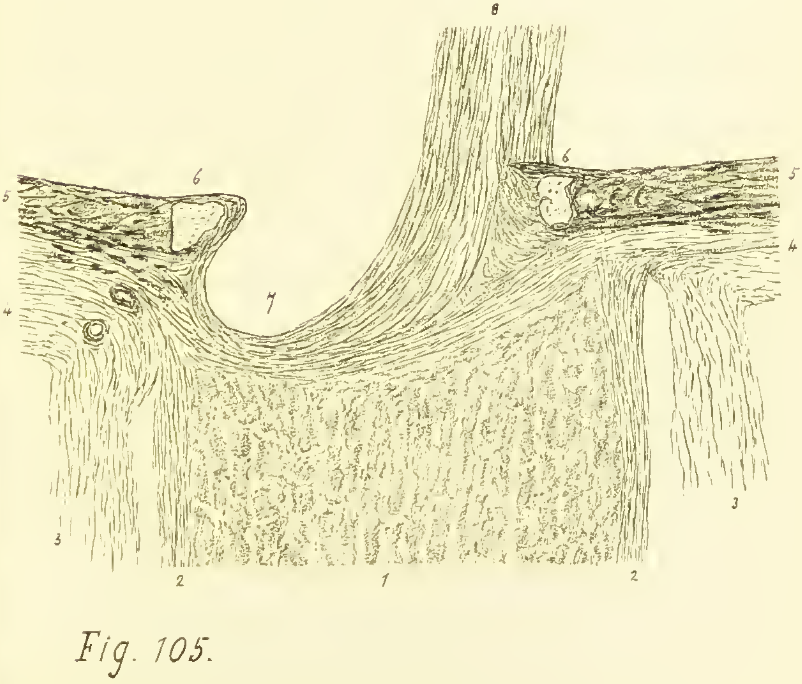

Fig. 105.

C. Fred Pollock, del.

Oatts & Runciman, Glasgow, Imp.

PLATE XLVI.

Fig. 106.—Vertical Section of Atrophied Choroid.

× 300. Glycerine.

1. Choroid, converted into a thin layer of dense fibrous tissue, without vessels, in which the remains of the pigmented cells of the stroma are embedded. 2. Pigmented epithelium unaltered. 3. This layer has become detached here in preparing the specimen. 4. Clear granular material, with nodulated surface, lying on the inner surface of the choroid.

Fig. 107.—Longitudinal Section of Entrance of Optic Nerve in Posterior Staphyloma and Glaucoma.

× 30. Glycerine.

This is from the right eye of a woman, forty-five years of age, which had been affected for years with glaucoma along with posterior staphyloma and a staphylomatous bulging in the upper ciliary region. Fig. 157 shows the condition of one part of the ciliary region.

1. Bundles of nerve fibres. 2. Central blood-vessels. 3. Sheaths of optic nerve. 4. Sclerotic. 5. Choroid. 6. Retina. 7. Choroid, over the staphyloma at the side next the macula lutea. It has become accidentally detached from the sclerotic in mounting the specimen, and is much atrophied, especially close to the disc. 8. Retina, with its layers greatly thinned. 9. The retina and choroid are here represented by thin layers of fibrous tissue. 10. Glaucomatous excavation of optic disc. This is much more marked in the part next the staphyloma; and very few fibres pass to the retina at this side.

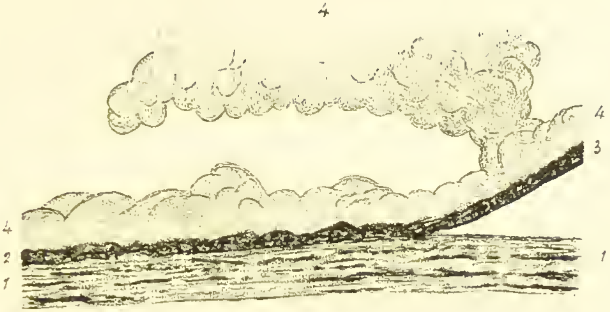

Fig. 106.

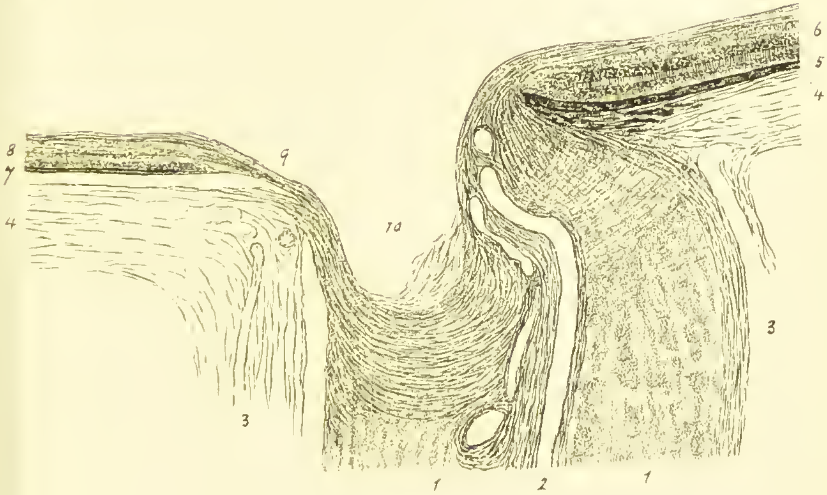

Fig. 107.

C. Fred Pollock, del.

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PLATE XLVII.

Fig. 108.—Vertical Section of Margin of Optic Disc with Posterior Staphyloma.

× 200. Glycerine.

This is from another section of the same eye as Fig. 107; it corresponds in position with No. 9 in that figure.

1. Internal layers of sclerotic. 2. Above this there is a transverse section of a blood-vessel near the inner surface, with some pigmented cells in its neighbourhood. 3. Atrophied choroid, consisting of dense fibrous tissue, with some pigment towards the left side. 4. Pigmented epithelium. It is absent for some distance at the side of the disc, and at the margin of this area there is an accumulation of pigmented cells, while immediately nearer the disc than that there are a few large non-pigmented cells. 5. Rod and cone layer of retina. 6. External nuclear layer. 7. Internal nuclear layer. 8. Layer of nerve fibres. The nerve cells are wanting, and the retina is considerably thinned in this region. 9. The retina and choroid are here represented by firmly united thin layers of fibrous tissue, sloping downwards at the edge of the excavated disc. The internal nuclear layer extends much closer to the disc than the others.

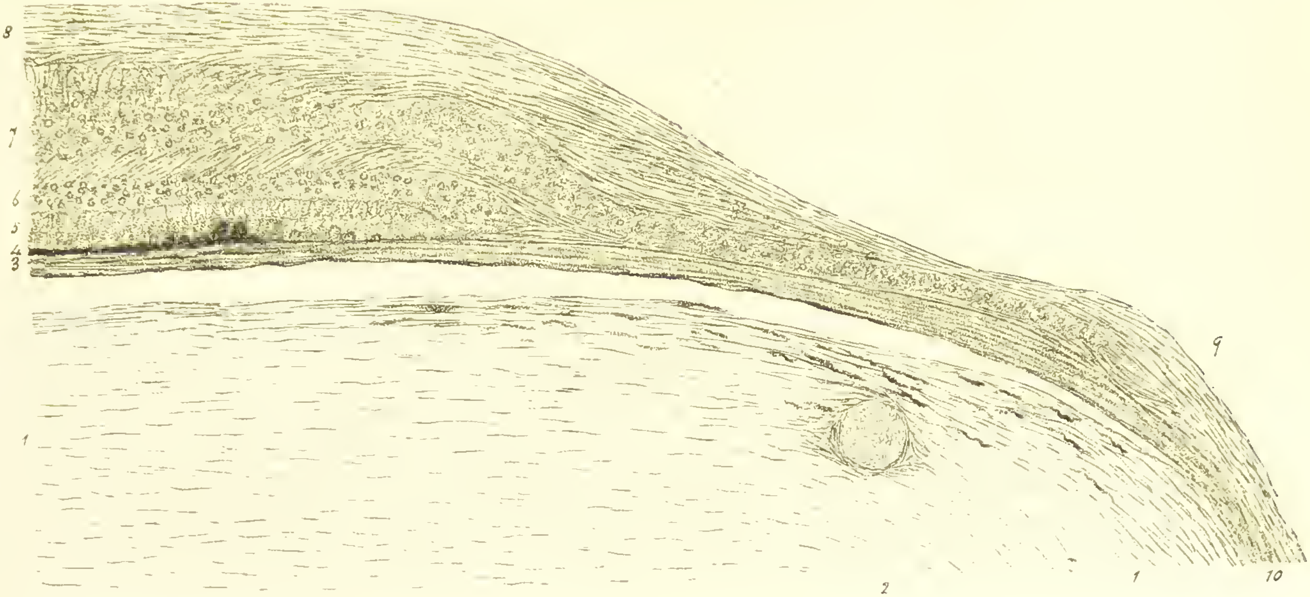

Fig. 108.

PLATE XLVIII.

FIG. 109.—Vertical Section of Fundus with Spindle-celled Sarcoma of Choroid and Glaucoma.

× 6. Stained, Dammar.

This is from a man, sixty years of age. There was a history of repeated attacks of iritis during the four years which preceded the enucleation of the eyeball. The condition of the ciliary region is shown in Figs. 159 and 160.

1. Longitudinal section of optic nerve. 2. Inner sheath of nerve. 3. Outer sheath. 4. Sclerotic. 5. Choroid. 6. Retina, detached. 7. Clear granular, coagulated material between choroid and retina. 8. Choroid, near tumour. 9. Anterior margin of tumour, with much pigment. 10. Tumour, in which are seen sections of vessels. Scattered pigment gave the whole growth a grey appearance. 11. Fibrous remains of retina, covering part of the tumour. The optic disc has a glaucomatous excavation.

Pl. XLVIII

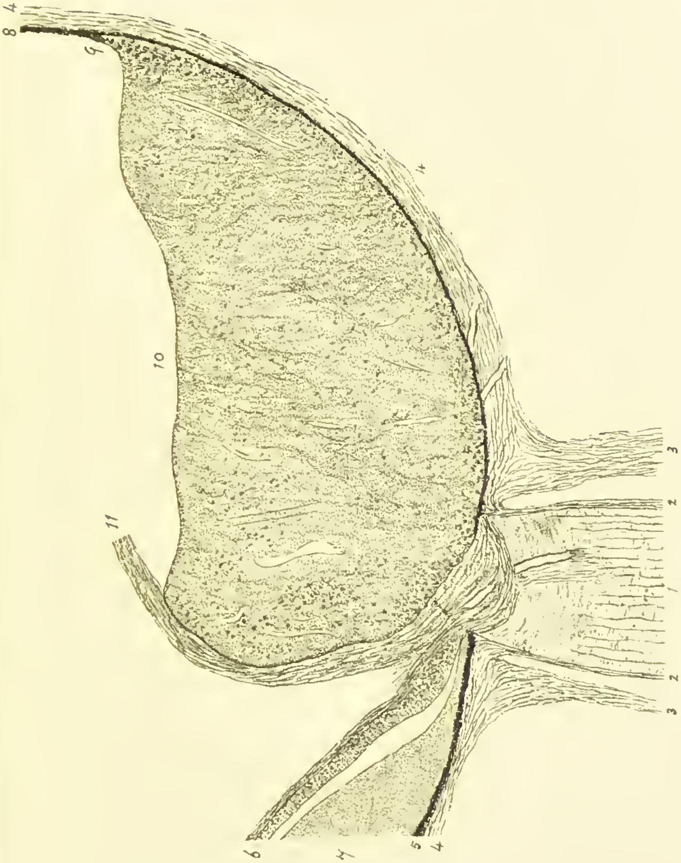

Fig. 109.

C. Fred Pollock, del.

Oatts & Runciman, Glasgow, Imp.

PLATE XLIX.

Fig. 110.—Section of Round-celled Sarcoma, invading the Sclerotic.

× 400. Glycerine.

This is from a case, in which the eyeball was completely destroyed by an intra-ocular round-celled sarcoma.

1. Fibrillæ of sclerotic, near the place where the tumour had penetrated from within outwards. 2. Large round cells of sarcoma, lying between the bundles of fibres.

Fig. 111.—Isolated Spindle-shaped and Roundish Cells, without Pigment, from Sarcoma recurrent after Enucleation of the Eyeball.

× 300. Glycerine.

Fig. 112.—Isolated Spindle-shaped and Roundish Pigmented Cells from Recurrent Sarcoma.

× 300. Glycerine.

This is from the same case as Fig. 111.

Pl. XLIX

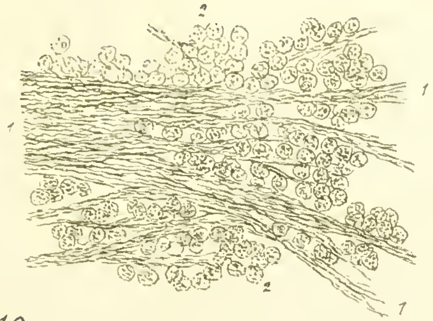

Fig. 110.

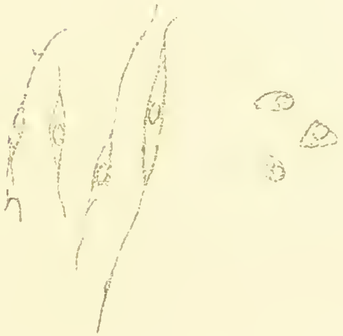

Fig. 111.

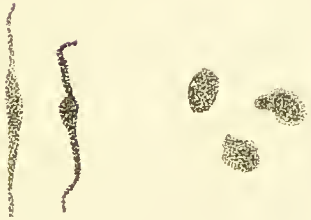

Fig. 112.

C. Fred. Pollock, del.

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PLATE L.

Fig. 113.—Meridianal Section of Corneo-scleral Junction, with Schlemm's Canal.

× 120. Glycerine.

1. Inner layers of cornea. 2. Margin of Descemet's membrane. 3. Posterior epithelial layer of cornea. 4. Inner layers of sclerotic, behind the canal of Schlemm. The annular bundles are cut transversely. 5. Anterior part of ciliary muscle. 6. Ligamentum pectinatum. The layers pass from the margin of Descemet's membrane to the sclerotic, the ciliary muscle, and the iris. 7. Layers of sclerotic. The most internal bundles have an annular course, and are cut transversely. Beneath them is the space, known as the canal of Schlemm. 8. Below this there is a cross section of a small blood-vessel.

Fig. 114.—Internal Surface of the Periphery of Descemet's Membrane and adjacent part of Ligamentum Pectinatum.

× 200. Stained, Glycerine.

1. Descemet's membrane. 2. In this region there are many small, clear, hyaline prominences. (Hassall's warty bodies.) 3. Posterior epithelial layer of cornea. 4. Nuclei between Hassall's wart-like projections. The epithelial cells, to which they belong, are not distinguishable. 5. The membrane of Descemet is here directly continuous with the ligamentum pectinatum, and some fine annular fibres, adherent to the outer surface, are seen through this part. 6. Inner fibres and attached nuclei of ligamentum pectinatum.

Fig. 115.—Ligamentum Pectinatum.

× 300. Stained, Glycerine.

The coarse fibres have an intricate arrangement, and form a fenestrated membrane. Nuclei adhere to them, and remains of epithelial cells are present at some places.

Pl. L

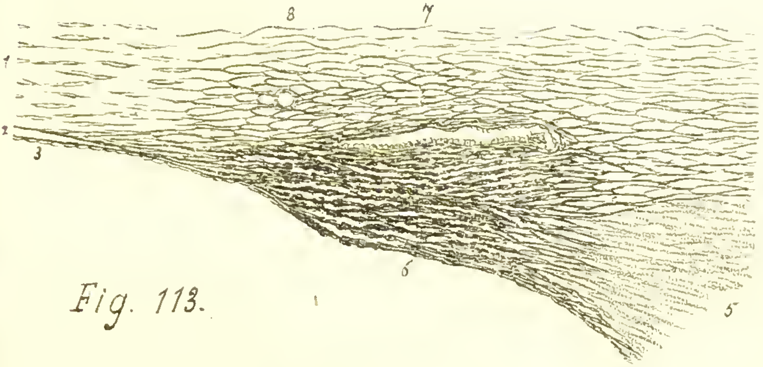

Fig. 113.

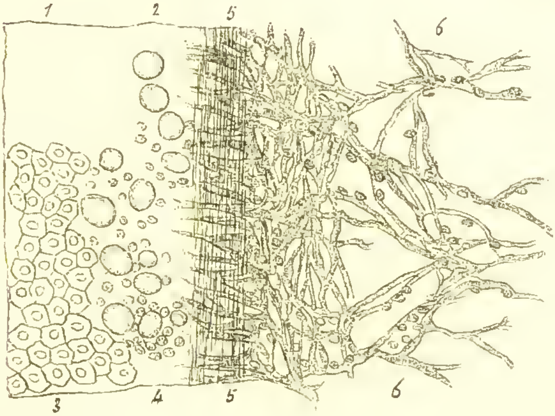

Fig. 114.

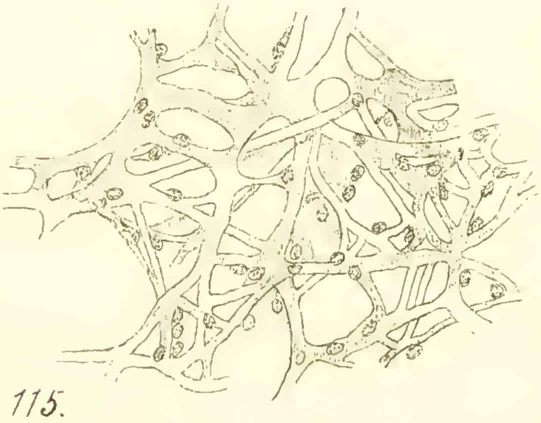

Fig. 115.

G. Fred. Pollock, del.

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PLATE LI.

Fig. 116.—Meridianal Section of Ciliary Region.

× 6. Glycerine.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Iris. 5. Ciliary body. This has fallen away from the sclerotic, as frequently happens in mounting specimens. 6. Choroid. 7. Periphery of retina. 8. Ora serrata, where the retina passes into the pars ciliaris retinæ.

Fig. 117.—Meridianal Section of Ciliary Region of Child.

× 30. Glycerine.

This is from a child, nine months old.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Ligamentum pectinatum and Schlemm's canal, at iritic angle or angle of anterior chamber. 5. Iris. 6. Ciliary muscle. 7. Ciliary process. 8. Anterior part of ciliary process. 9. Pigment layer of ciliary body, with pars ciliaris retinæ. 10. Fibres of zonula of Zinn.

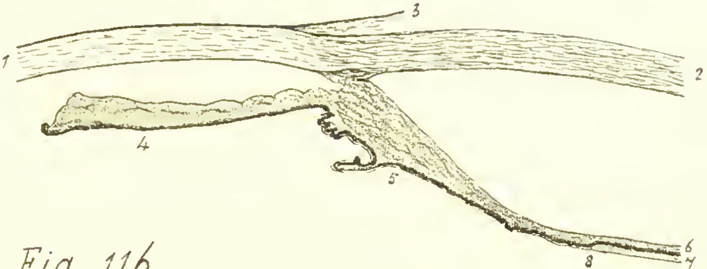

Fig. 116.

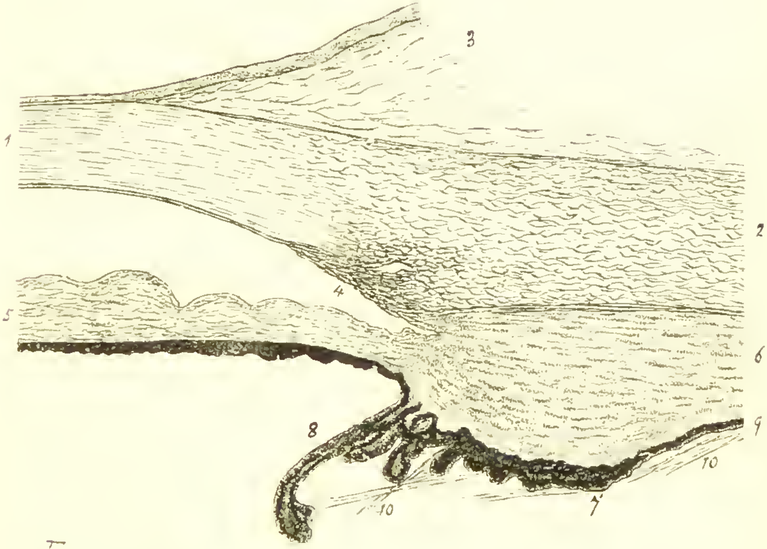

Fig. 117.

C. Fred. Pollock, del.

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PLATE LII.

Fig. 118.—Meridianal Section of Ciliary Region of Adult.

× 30. Glycerine.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Ligamentum pectinatum and Schlemm's canal, at angle of anterior chamber. 5. Iris. 6. Ciliary muscle. 7. Ciliary process. 8. Anterior part of ciliary body. The circulus arteriosus iridis major is seen cut across. 9. Pigment layer and pars ciliaris retinæ. 10. Fibres of zonula.

Fig. 119.—Isolated Branched Pigmented Cells from Ciliary Body.

× 300. Dammar.

The processes of two of them unite.

Fig. 120.—Meridianal Section of Ciliary Body of Negro.

× 30. Glycerine.

1. Anterior extremity. 2. Posterior part. 3. Fibres of zonula. Many pigmented cells lie between the bundles of the ciliary muscle

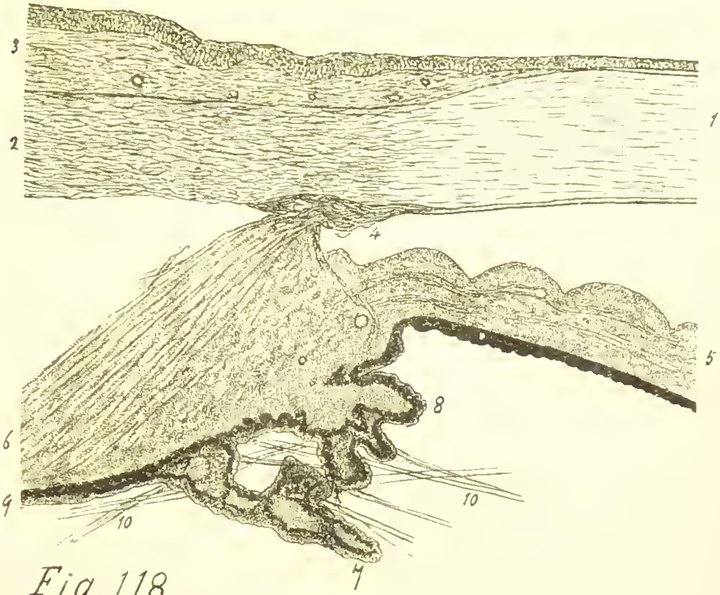

Fig. 118.

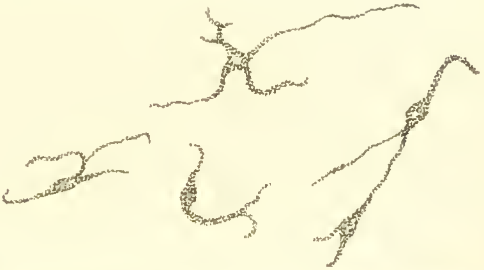

Fig. 119.

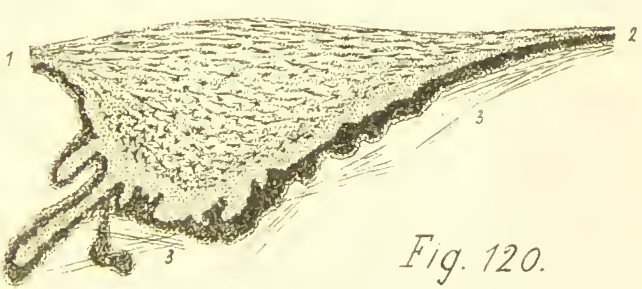

Fig. 120.

C Fred Pollock, del.

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PLATE LIII.

Fig. 121.—Meridianal Section of Ciliary Region.

× 10. Glycerine.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. 4. Iris. 5. Ciliary body, fallen away from sclerotic in mounting the specimen. 6. Ligamentum pectinatum and Schlemm's canal, at angle of anterior chamber.

Fig. 122.—Meridianal Section of Ciliary Region.

× 10. Glycerine.

Numbers as in Fig. 121. The ciliary body is short and thick in this specimen.

Fig. 123.—Meridianal Section of Ciliary Region.

× 10. Glycerine.

Numbers as in Fig. 121. The ciliary body is long and thin in this specimen, which is from the same eye as Fig. 122.

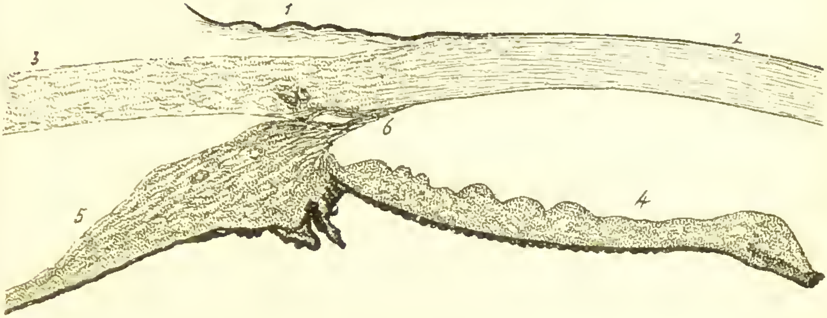

Fig. 121.

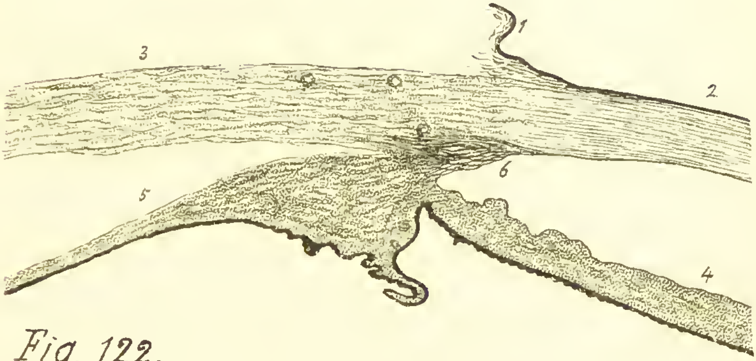

Fig. 122.

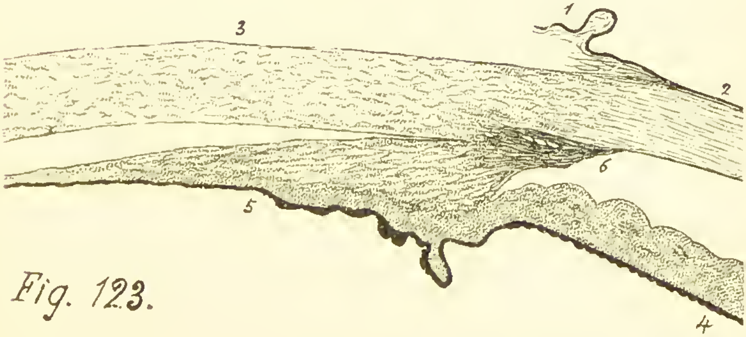

Fig. 123.

C. Fred Pollock, del.

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PLATE LIV.

Fig. 124.—**Meridianal Section of Ciliary Region.**

× 10. Glycerine.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. 4. Iris. 5. Ciliary body. 6. Ligamentum pectinatum and Schlemm's canal, at angle of anterior chamber.

Fig. 125.—**Meridianal Section of Ciliary Region.**

× 10. Glycerine.

Numbers as in Fig. 124.

Fig. 126.—**Meridianal Section of Ciliary Region.**

× 10. Glycerine.

This is from a child eleven months old.
Numbers as in Fig. 124.

Pl. LIV

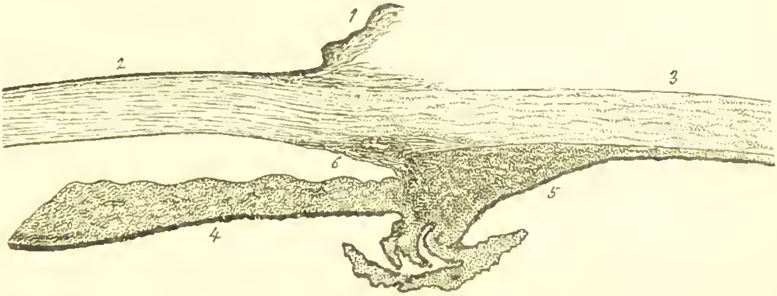

Fig. 124.

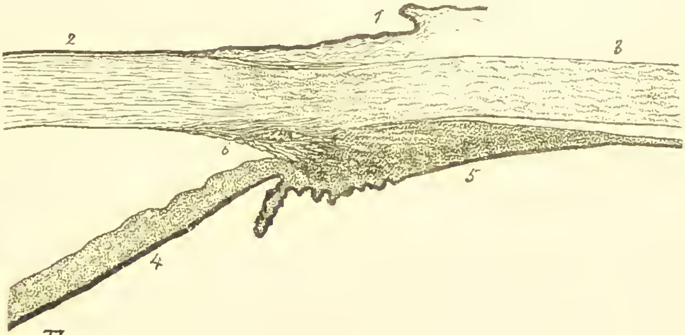

Fig. 125.

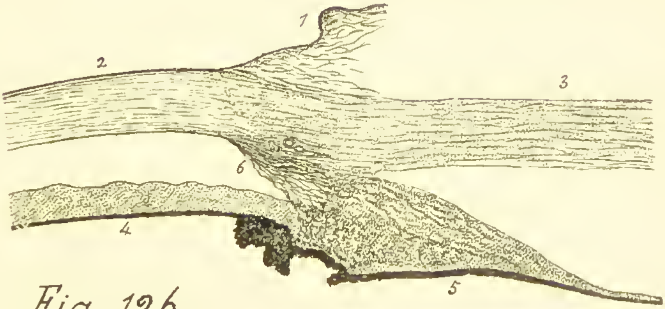

Fig. 126.

C. Fred Pollock, del.

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PLATE LV.

Fig. 127.—Transverse Section of Ciliary Body.

× 30. Glycerine.

This is from the anterior part of the pars non-plicata.

1. Outer surface. 2. Pigment layer. 3. Pars ciliaris retinæ.

Fig. 128.—Transverse Section of Ciliary Body.

× 30. Glycerine.

This is from the posterior part of the pars plicata, a short distance in front of Fig. 127.

1. Outer surface. 2. Pigment layer and pars ciliaris retinæ. The hinder portions of the ciliary processes are seen cut across.

Fig. 129.—Transverse Section of Ciliary Body.

× 30. Glycerine.

This is from the pars plicata, a short distance in front of Fig. 128.

1. Outer surface. 2. Inner surface, with ciliary processes cut across. In the middle of the figure there are masses of pigment, covering the floors of depressions running backwards from the anterior surface of the ciliary body.

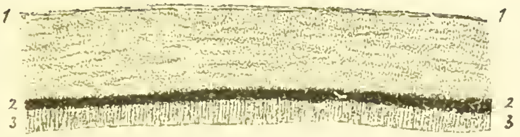

Fig. 127.

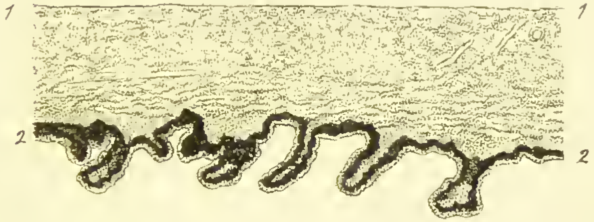

Fig. 128.

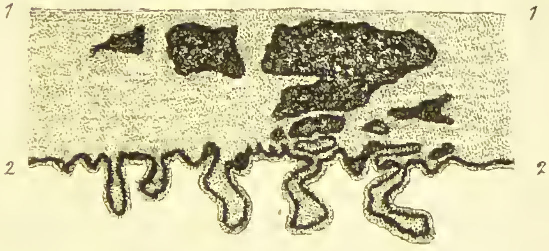

Fig. 129.

C. Fred. Pollock, del.

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PLATE LVI.

Fig. 130.—Transverse Section of Iris with Ciliary Processes.

× 30. Glycerine.

As the section is from a ring (the iris), it is necessarily tangential and, therefore, somewhat oblique. The right side of the figure is nearer the pupil than the left.

1. Anterior surface of iris. 2. Transverse sections of extremities of ciliary processes, continued as radiating ridges on the posterior surface of the iris. 3. Anterior portions of prominent ciliary processes.

Fig. 131.—Transverse Section of Ciliary Body.

× 30. Glycerine.

This is from the most anterior part of the pars plicata, a short distance in front of Fig. 132.

1. Ciliary body, close to iris. 2. Compound ciliary processes, cut across.

Fig. 132.—Transverse Section of Ciliary Body.

× 30. Glycerine.

This is from the pars plicata, a short distance behind Fig. 131 and in front of Fig. 129.

1. Outer surface. 2. Inner surface, with ciliary processes cut across. The section is somewhat oblique, and the right side is further back than the left. Towards the right and in the middle of the figure depressions, running backwards in the substance of the ciliary body, are seen as spaces lined with pigment. At the left side the anterior border of a depression is cut obliquely, and forms a large irregular space.

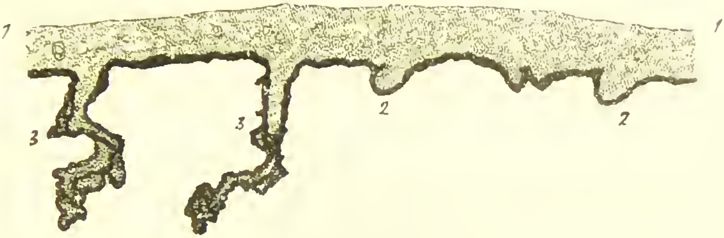

Fig. 130

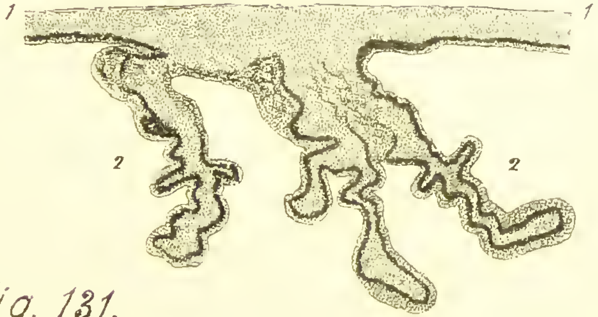

Fig. 131.

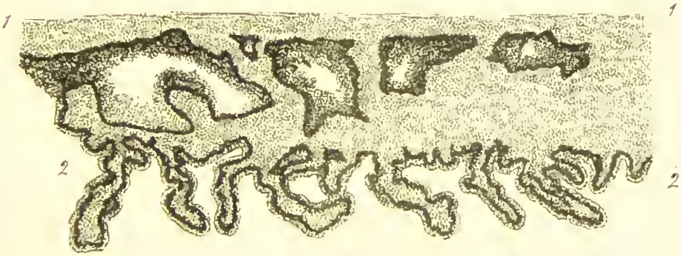

Fig. 132

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PLATE LVII.

Fig. 133.—**Vertical Section of inner layers of Ciliary Body.**

× 300. Glycerine.

This is from a negro, at the pars non-plicata.

1. Inner part of ciliary body. 2. Lamina vitrea, with depressions and ridges on the internal surface. 3. Pigment layer. It is very thick, and the outer surface has rounded elevations. It has become separated from the lamina vitrea in preparing the specimen. 4. Pars ciliaris retinæ.

Fig. 134.—**Internal Surface of Lamina Vitrea of Ciliary Body.**

× 200. Glycerine.

This is from the middle zone of the corpus ciliare, and the pigment has been brushed off.

1. Ridges. 2. Intervening depressions, some of which are still occupied by masses of pigment.

Fig. 135.—**Vertical Section of Pars Ciliaris Retinæ.**

× 300. Glycerine.

1. Inner part of ciliary body. 2. Pigment layer, thin. 3. Pars ciliaris retinæ, near its posterior margin.

Fig. 136.—**Vertical Section of Ora Serrata and Pars Ciliaris Retinæ.**

× 300. Glycerine.

1. Inner part of choroid. 2. Pigment layer. 3. Periphery of retina, or ora serrata. 4. Membrana limitans interna. 5. Inner part of ciliary body. 6. Pars ciliaris retinæ. 7. Vitreous. 8. Fibrillated area in vitreous.

Pl. LVII

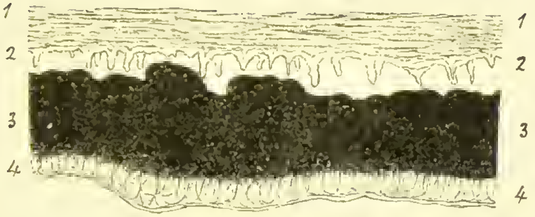

Fig. 133.

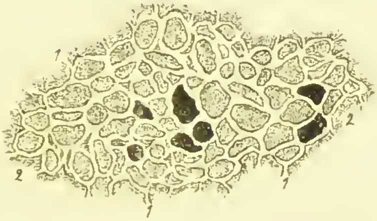

Fig. 134.

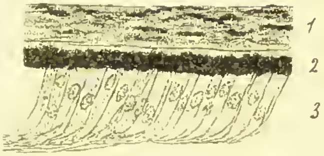

Fig. 135.

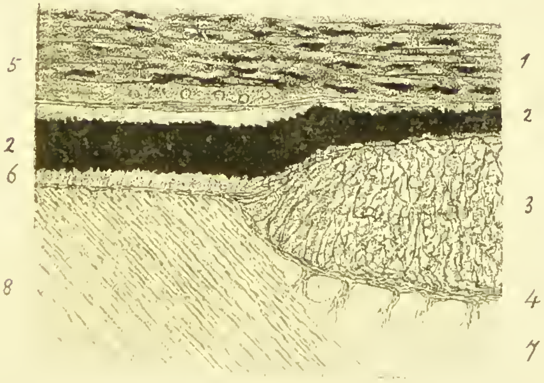

Fig. 136.

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PLATE LVIII.

FIG. 137.—**Meridianal Section of Ciliary Region in Irido-cyclitis with Exudation into Posterior Chamber.**

× 10. Glycerine.

This is from a boy, fifteen years of age, whose left eye was wounded in the ciliary region at the upper and outer part. The wound healed; but irido-cyclitis supervened, and then softening with partial shrinking of the globe. The eyeball was enucleated five months after the injury. Besides the condition shown in the figure, the retina was completely detached from the choroid and funnel-shaped, passing forwards as a cord from the disc (see Fig. 204), and expanding to its other attachment at the ora serrata.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Ciliary body. 5. Iris, adherent to capsule of lens at pupil, stretched, and bulged forwards. 6. Capsule of lens. 7. Fibres, passing from ciliary body to posterior surface of capsule. 8. Transparent slightly granular material, behind iris and between ciliary body and lens.

FIG. 138.—**Fibrine in Ciliary Body with Cyclitis.**

× 300. Glycerine.

1. Thick fibres. 2. Thin fibres. 3. Large vesicles and circles. 4. Small vesicles, circles, and cup-shaped bodies.

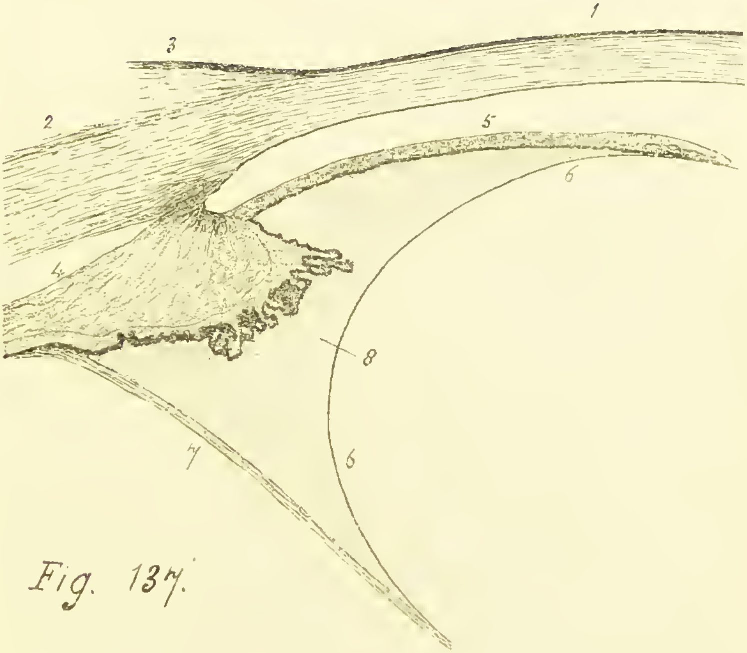

Fig. 137.

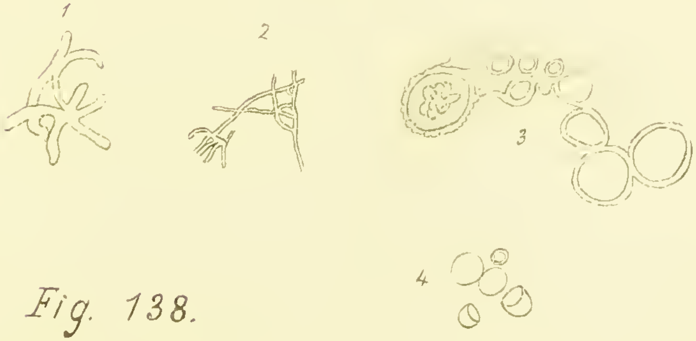

Fig. 138.

C. Fr[illegible] del.

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PLATE LIX.

Fig. 139.—Meridianal Section of lateral portion of Eyeball with Enlarged and Spongy Ciliary Body in Cyclitis with Œdema.

× 6. Glycerine.

This is from the left eye of a girl, which was enucleated when she was fourteen years of age. It was then blind and partially atrophied, having been troublesome since infancy. The cornea was opaque and vascular; the anterior chamber was obliterated; and fragments of the iris with pigment adhered to the cornea. A cyclitic mass occupied the anterior portion of the vitreous chamber, connected with the ciliary body and the remains of the iris; it contained the folded-up capsule of the lens, traces of the otherwise destroyed retina, and hyaline bodies. The choroid lined the remaining part of the eyeball.

1. Sclerotic at fundus. 2. Sclerotic at junction with cornea. 3. Conjunctiva. 4. Choroid. 5. Blood-vessel, passing through sclerotic to choroid. 6. Anterior extremity of ciliary body. 7. Border of cyclitic membrane, which passed across the anterior segment of the globe. The ciliary body and adjacent part of the choroid are much swollen; they are separated from the sclerotic by a fibrinous exudation, and form a loose tissue, in the meshes of which lie large masses of fibrine.

Fig. 140.—Part of Enlarged and Spongy Ciliary Body in Cyclitis.

× 300. Glycerine.

1. Connective-tissue fibres, forming loose net-work. 2. Branched pigmented cells of stroma. 3. Large round granular cells, some of which show a nucleus. There are also some smaller granular nucleated round cells. 4. Red blood corpuscles.

PL. LIX

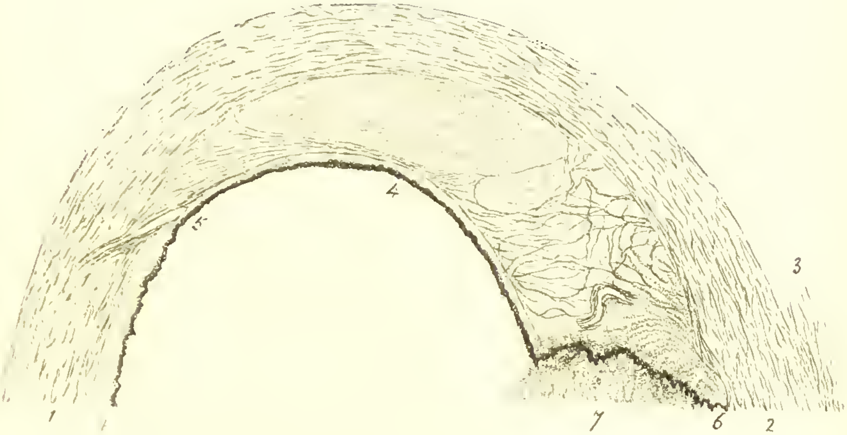

Fig. 139.

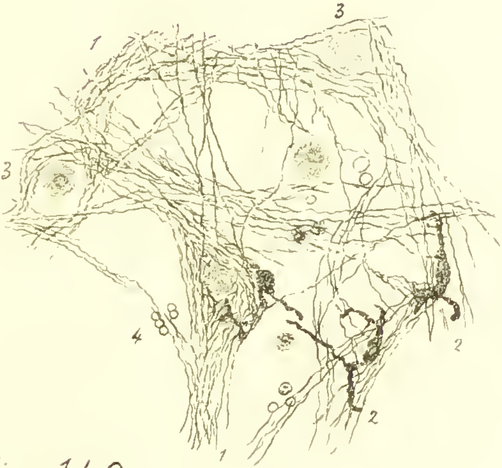

Fig. 140.

C. Fred. Pollock, del.
Oatts & Runciman, Glasgow, Imp.

PLATE LX.

Fig. 141.—Stroma of Ciliary Body with Cyclitis.

× 300. Glycerine.

1. Connective tissue. 2. Small collection of inflammatory round cells. 3. Branched and round pigmented cells of stroma. 4. Scattered granular corpuscles.

Fig. 142.—Pigmented Cells in Ciliary Body with Cyclitis and Hæmorrhage.

× 300. Glycerine.

Embedded in the stroma there are pigmented cells from the neighbourhood of a blood-clot; they are of various sizes, with clear walls, containing large brownish granules.

Fig. 143.—Vertical Section of inner layers of Ciliary Body with Cyclitis.

× 200. Glycerine.

1. Inner part of ciliary body, crammed with round cells. 2. Pigment layer; the outer surface is broken up and irregular, and the lamina vitrea cannot be seen. 3. Pars ciliaris retinæ, detached at one spot, where there is a sharply defined space, containing round cells. Leucocytes are present in the inner part of this layer also.

Fig. 144.—Vertical Section of Pars Ciliaris Retinæ in Cyclitis.

× 300. Glycerine.

1. Pigment layer of ciliary body. 2. Pars ciliaris retinæ, swollen and infiltrated with round cells. 3. Fibres of zonula, with some inflammatory cells.

Pl. LX.

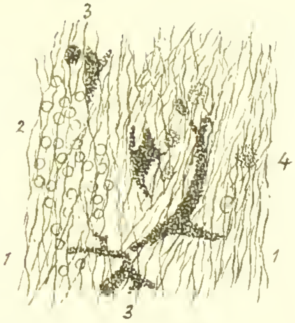

Fig. 141

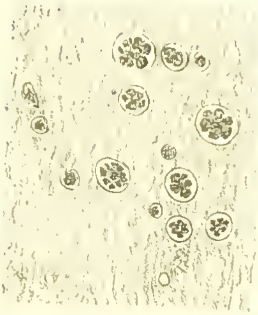

Fig. 142.

Fig. 143.

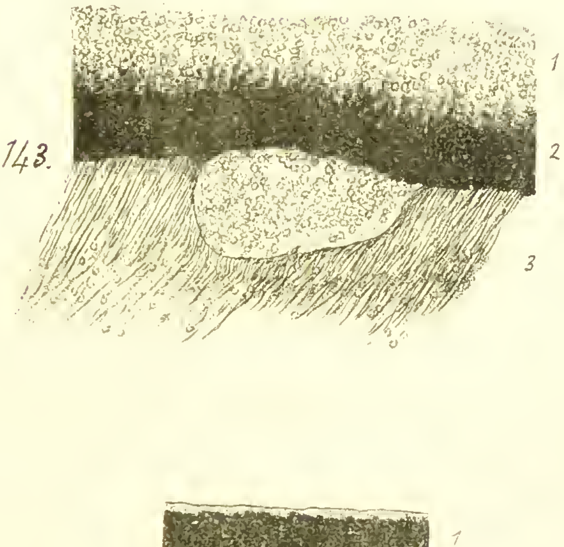

Fig. 144.

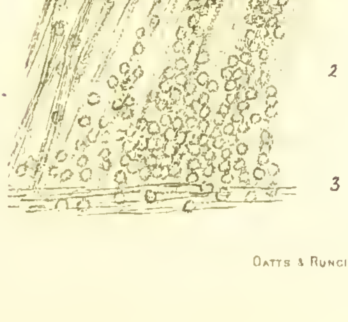

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PLATE LXI.

Fig. 145.—Inner part of Ciliary Body with Purulent Cyclitis.

× 300. Logwood, Dammar.

1. Fibres of ciliary muscle, nuclei stained. 2. Inflammatory round cells. Some irregular pigmented cells of the stroma are present (brown in the specimen). 3. Pigment layer (black in the specimen). 4. Pars ciliaris retinæ. 5. Fibres of zonula, with one or two round granular cells.

Fig. 146.—Meridianal Section of Ciliary Region with Purulent Cyclitis and Iritis.

× 20. Logwood, Dammar.

This is from a woman, forty-two years of age, whose left eye received a blow five weeks before enucleation. Some cicatricial tissue, in which the iris was involved, existed in the ciliary region at the upper and outer part of the eyeball. Elsewhere iritis and hypopyon were present; the ciliary body was inflamed; and the choroid was greatly thickened by purulent infiltration.

1. Cornea. 2. Sclerotic, with collections of round cells about the blood-vessels. 3. Conjunctiva, with leucocytes in the neighbourhood of the vessels. 4. Limbus conjunctivæ, with infiltration of inflammatory cells (conjunctivitis). 5. Iris, crammed with inflammatory cells. 6. Ciliary body. This is greatly enlarged, and is infiltrated throughout with round cells, which in the inner layers of the stroma form densely packed masses.

Pl. XI

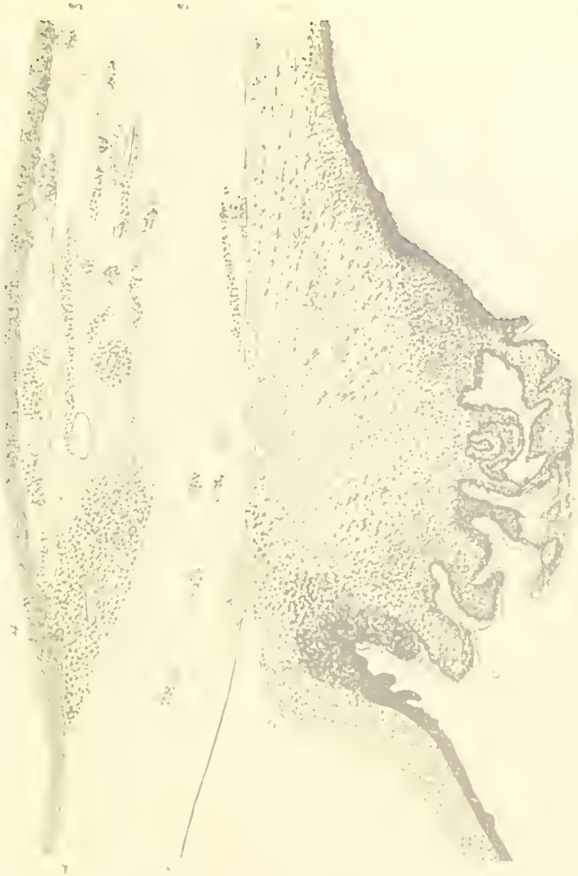
Fig. 140

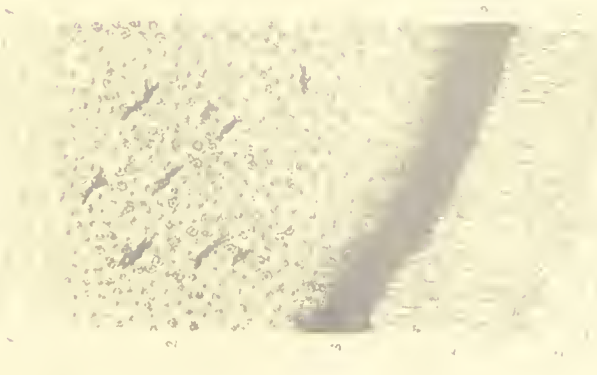
Fig. 14[illegible]

Fac. Pollock [illegible]

Att & Feneman [illegible]

PLATE LXII.

Fig. 147.—**Fibres and large round granular Cells from Cyclitic Membrane.**

× 300. Glycerine.

Fig. 148.—**Pigmented Cells in Cyclitic Membrane.**

× 300. Glycerine.

1. Pigment layer of ciliary body. 2. Free granules of pigment. 3. Large roundish pigmented cells in cyclitic membrane. The pars ciliaris retinæ cannot be distinguished.

Fig. 149.—**Formation of Bone in Cyclitic Membrane.**

× 30. Glycerine.

This is from the same case as Fig. 150.

1. Cyclitic membrane. 2. Masses of pigment. 3. Sections of spicules of bone.

Pl. LXII

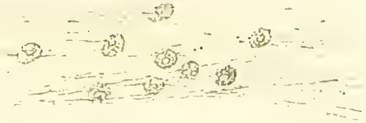

Fig. 147.

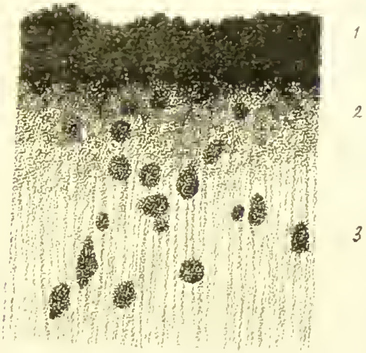

Fig. 148.

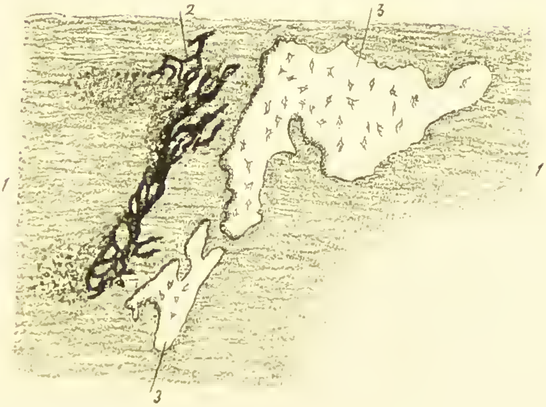

Fig. 149.

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PLATE LXIII.

Fig. 150.—Meridianal Section of lateral portion of Eyeball with Cyclo-choroiditis and Detachment of Ciliary Body and Choroid.

× 6. Logwood, Dammar.

This is from an eye, which was injured by a blow ten years before enucleation. Cataract resulted at the time of the accident, and an operation of some kind was performed. On examining a horizontal section of the eyeball from before backwards, the pupil was found to be small and displaced to the side, lying behind a cicatrix in the cornea. The centre of the globe was occupied by a dense membranous formation, conical in shape, with the base stretched across the anterior part from the ciliary processes, and the apex attached at the optic disc. In this membrane, which contained spicules of bone, the retina was lost and could not be distinguished. A space occurred between the central mass and the choroid. This figure shows the condition of the ciliary region and the adjacent parts on the side furthest from the pupil; and Fig. 153 the ciliary region near the displaced pupil. Between the point marked 6 in Fig. 150 and the optic disc a plate of bone, 6 by 11 millimètres in breadth, was situated in the choroid.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Iris. 5. Ciliary muscle. 6. Choroid, which is detached in front of this point. 7. Fibrous membrane, rich in cells, attached to the ciliary body and the choroid, which are both dragged away from the sclerotic. 8. Loose spongy tissue outside ciliary body and choroid, with fibres and blood-vessels; the large spaces of the tissue contain masses of granular material.

Fig. 151.—Meridianal Section of Ciliary Region with Cyclo-choroiditis and Detachment of Ciliary Body and Choroid.

× 30. Logwood, Dammar.

1. Inner layers of cornea. 2. Inner layers of sclerotic. 3. Periphery of iris. 4. Ciliary body. 5. Choroid. 6. Newly formed membrane, attached to ciliary body and choroid, which are detached from their normal position. 7. Spongy tissue outside ciliary body and choroid. It is composed of a loose net-work of delicate fibrous tissue, with many cells and blood-vessels, and some masses of pigment. The bulk of this area is occupied by amorphous, granular, coagulated material and some strings of fibrine.

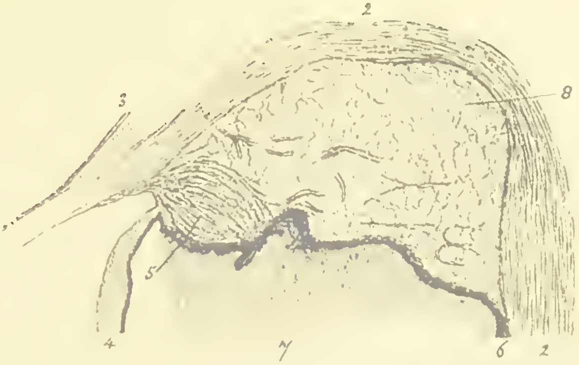

Fig 150.

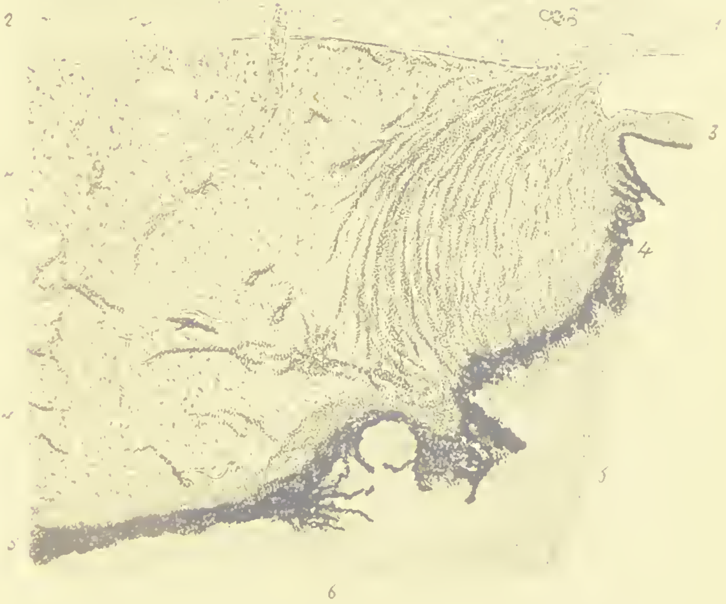

Fig. 151.

PLATE LXIV.

Fig. 152.—Anterior portion of Eyeball with Iridocyclitis.

× 10. Glycerine.

This is from the right eye of a man, thirty years of age. The cornea received an extensive wound, which led to immediate and copious hæmorrhage, followed by prolapse of the iris and loss of vitreous. The lens became opaque, and an iritic membrane filled the pupil. The eyeball began to shrink, and was removed thirty-nine days after the accident.

1. Conjunctiva. 2. Sclerotic. 3. Cornea. 4. Cicatrix of wound, passing obliquely through the cornea, with some pigment. 5. Iris, stretched and partly atrophied; it is adherent over most of its posterior surface to the capsule of the lens (synechia posterior), and is pushed forwards by the lens. 6. Pupillary margin of iris, involved in inflammatory material, with adhesions to cornea (synechia anterior) and lens. 7. Capsule of lens. The substance of the lens has dropped out of the section. 8. Folded remains of part of capsule, imbedded in cicatricial tissue. 9. Newly formed connective-tissue membrane, passing across eyeball behind the lens, which is displaced forwards. 10. Portions of detached and folded retina. 11. Ciliary body, dragged inwards. Some coagulated granular material and part of a ciliary process lie between this and the capsule of the lens. 12. Pigment layer of pars non-plicata of ciliary body. 13. Collections of pigmented cells in choroid, some of them from the stroma, and some containing blood-pigment, similar to the cells drawn in Fig. 99. 14. Choroid. 15. Blood-clot, splitting choroid into two layers. 16. Newly formed inflammatory membrane, replacing the various tissues in front of the ciliary body at this side. It is composed of fibres, round cells, blood-vessels, masses of pigment, and some remains of the stroma of the iris; and is covered externally by thickened epithelium, embedded in which are pigmented cells, granules of pigment, and other traces of the incarcerated and destroyed iris. Internally it is continuous with the membrane, extending across to the ciliary body on the opposite side.

Pl. LXIV

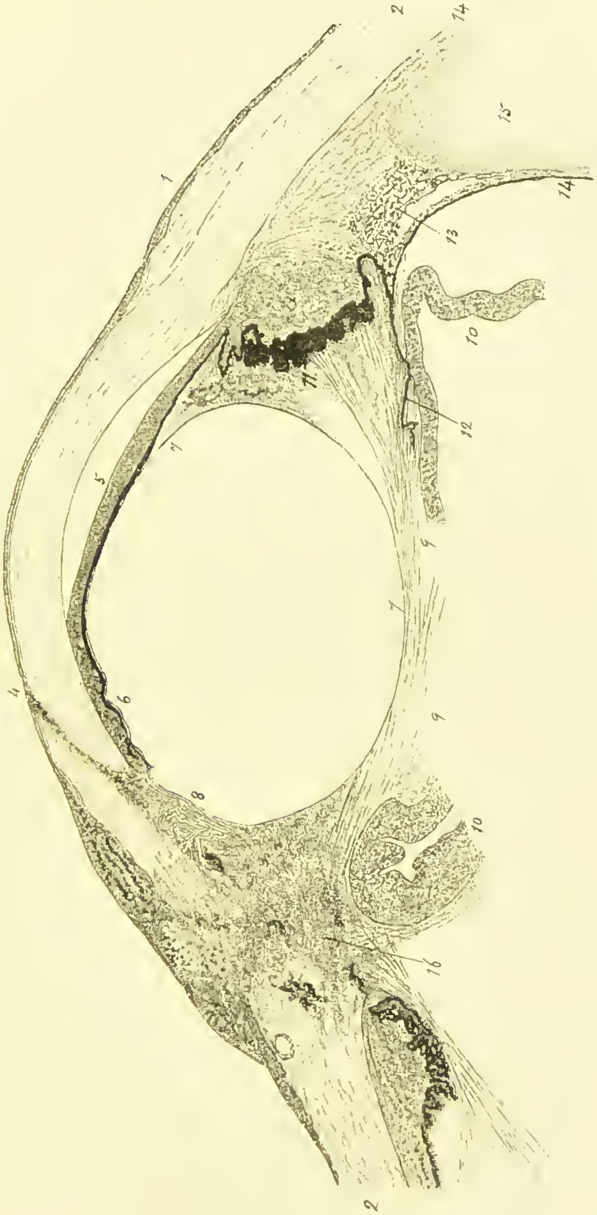

Fig. 152.

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PLATE LXV.

FIG. 153.—Meridianal Section of Ciliary Region after Cyclitis.

× 10. Logwood, Dammar.

For the history of the case see Fig. 150.

1. Cornea. 2. Sclerotic. 3. Conjunctiva. 4. Choroid detached from sclerotic. 5. Ciliary body. 6. Loose fibrous tissue outside choroid. 7. Remains of ciliary processes. 8. Pupillary portion of iris, isolated and attached to anterior surface of cyclitic membrane. 9. Cyclitic membrane, chiefly fibrous, and containing collections of round cells and scattered masses of pigment. 10. The corneo-scleral junction, dragged inwards by the adherent cyclitic membrane.

FIG. 154.—Meridianal Section of Ciliary Region with Wound.

× 10. Logwood, Dammar.

This is from a man, thirty-seven years of age, whose right eye received an extensive wound about the corneo-scleral junction, involving the ciliary body and iris. The wound healed in the course of a week; but the painful, tense, and blind eyeball was removed fifteen days after the injury. The region of the wound is shown in the figure; elsewhere the iris was attached to the capsule of the lens, the lens was cataractous, the retina was inflamed and partly detached by blood-clot and clear amorphous material, the choroid was the seat of hæmorrhage, and the vitreous behind the cyclitic membrane was replaced by blood-clot.

1. Cornea. 2. Sclerotic. 3. Choroid. 4. Ciliary body. 5. Ciliary processes. 6. Iris. 7. Inflammatory membrane, attached to the posterior portion of the ciliary body and to the wound, composed of delicate fibres and many cells. 8. Collections of inflammatory round cells. 9. Coagulated fibrine outside choroid. 10. At this place the wound penetrated the sclerotic, and divided the ciliary body. It is occupied by inflammatory material, covered by a thick layer of epithelium.

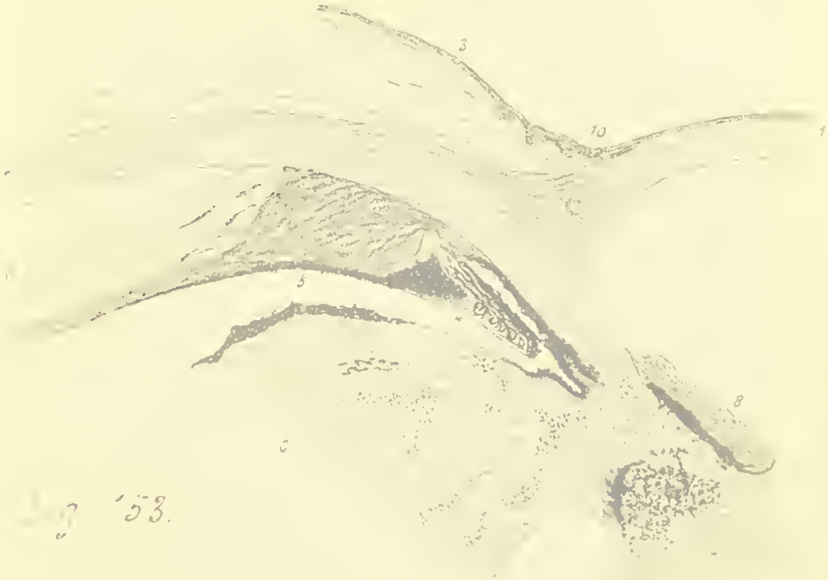

Fig. 153.

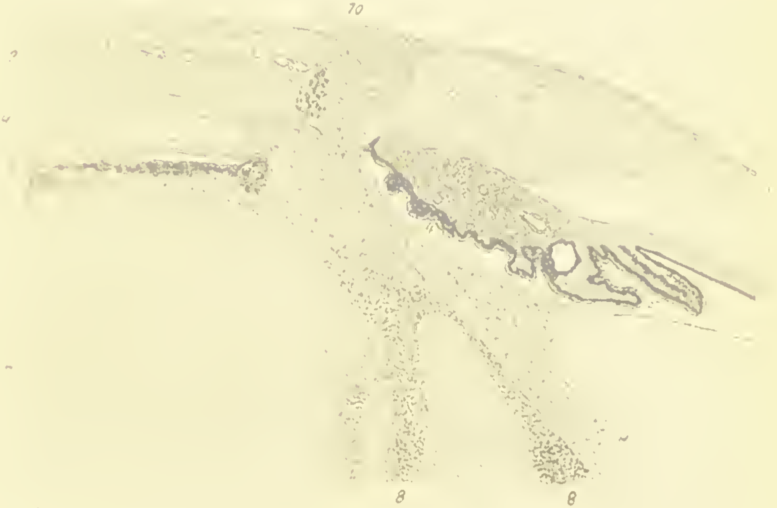

Fig. 154.

Oatts & Runciman Glasgow Imp.

PLATE LXVI.

Fig. 155.—Meridianal Section of Ciliary Region in Inflammatory Glaucoma.

× 10. Glycerine.

This is from the right eye of a woman, twenty-five years of age, with glaucoma of about three years' duration. There was inflammation of the cornea and iris at the time of enucleation. The optic disc is drawn in Fig. 178.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. 4. Free portion of iris with inflammatory cells. 5 to 6. Peripheral portion of iris, adherent to cornea and somewhat atrophied. This region bulges outwards slightly. 7. Ciliary body, much atrophied. 8. Layer of round cells and fibrine in anterior chamber (hypopyon).

Fig. 156.—Meridianal Section of Ciliary Region in Glaucoma.

× 10. Glycerine.

This is from the opposite side of the same eyeball as Fig. 155. Numbers as in that figure. The adherent peripheral portion of the iris is greatly atrophied.

Pl. XV

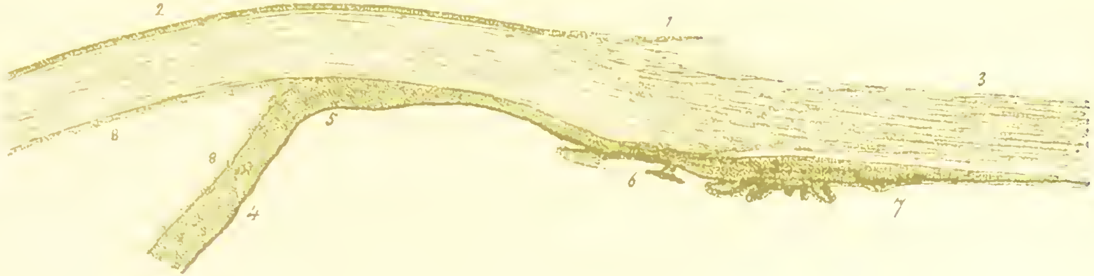

Fig. 155.

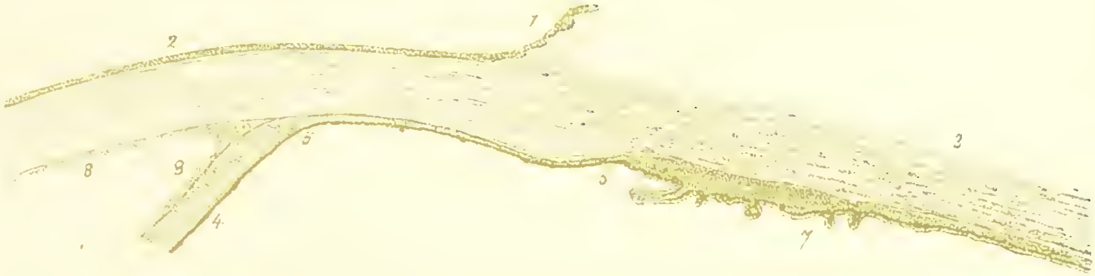

Fig. 156.

PLATE LXVII.

Fig. 157.—Meridianal Section of Ciliary Region in Chronic Glaucoma.

× 10. Glycerine.

This is from the same case as Fig. 107.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. 4. Pupillary portion of iris. 5. The iris is much atrophied in this region. 6. Peripheral part of iris, adherent to cornea, thick, and composed of loose tissue. 7. Ciliary body, greatly atrophied.

Fig. 158.—Meridianal Section of Angle of Anterior Chamber in Glaucoma.

× 45. Glycerine.

This is from the same case as Fig. 180.

1. Inner layers of cornea. 2. Sclerotic. 3. Anterior layers of iris near periphery. 4. Anterior extremity of ciliary muscle with ligamentum pectinatum. 5. Dense tissue, filling angle of anterior chamber.

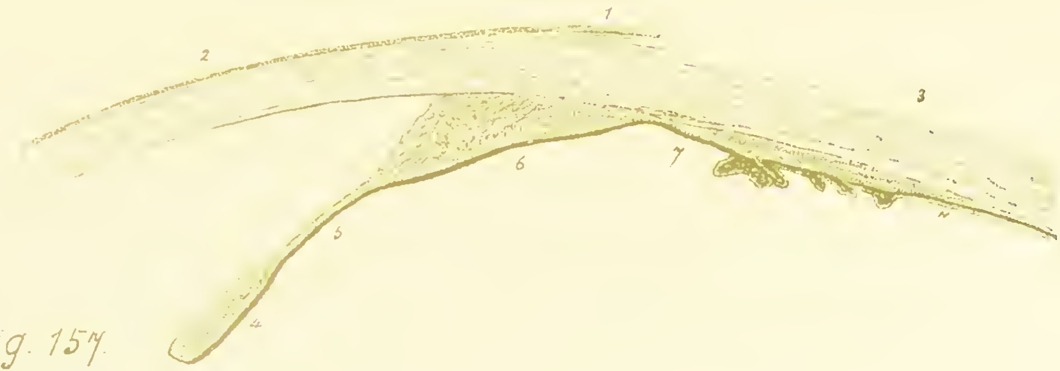

Fig. 157.

Fig. 158.

PLATE LXVIII.

Fig. 159.—Meridianal Section of Ciliary Region in Glaucoma secondary to Intra-ocular Tumour.

× 10. Glycerine.

This is from the same case as Fig. 109.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. 4. Pupillary margin of iris, everted. The uvea is continued on to the anterior surface. 5. Periphery of iris, adherent to cornea and somewhat atrophied. 6. Ciliary body, partially atrophied.

Fig. 160.—Meridianal Section of Ciliary Region in Secondary Glaucoma.

× 10. Glycerine.

This is from the opposite side of the same eyeball as Fig. 159. Numbers as in that figure. The pupil was displaced from the centre towards the side, from which Fig. 159 was taken. The difference in the extent of the iris is very marked.

Fig. 161.—Meridianal Section of Ciliary Region in Glaucoma.

× 10. Glycerine.

This is from the same case as Fig. 105.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. Many distended blood-vessels are present at the corneo-scleral junction. 4. Pupillary margin of iris. 5. The iris is at this point firmly attached to the opaque and vascular cornea, the part nearer the ciliary margin being quite free. 6. Peripheral portion of iris, adherent to cornea. 7. Ciliary body, greatly atrophied. The pars ciliaris retinæ is wanting; it was separated from the pigment layer by hæmorrhage and effusion of clear granular material.

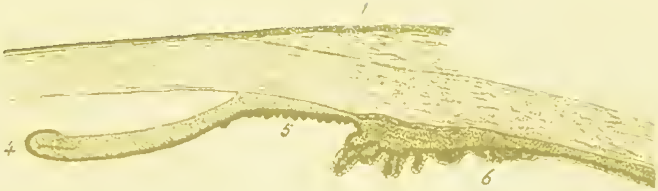

Fig. 159.

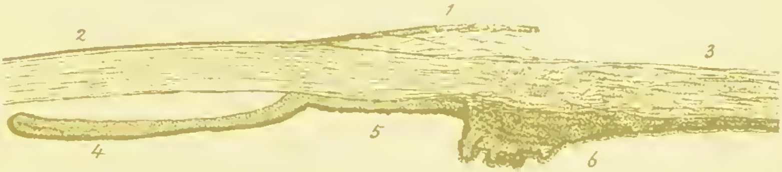

Fig. 160.

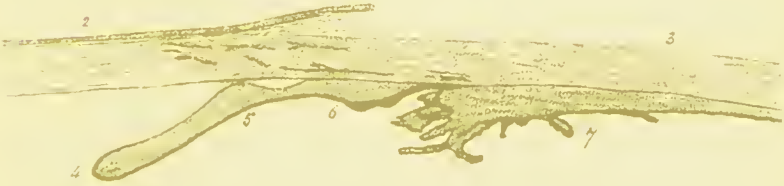

Fig. 161.

[illegible] Watts & Runciman Glasgow Imp.

PLATE LXIX.

Fig. 162.—Meridianal Section of Ciliary Region in Glaucoma.

× 10. Glycerine.

For the history of the case see Fig. 177.

1. Conjunctiva. 2. Cornea. 3. Sclerotic. 4. Free portion of iris, atrophied. 5 to 6. Periphery of iris, adherent to cornea and atrophied. 7. Ciliary body, greatly atrophied.

Fig. 163.—Meridianal Section of Ciliary Region in Glaucoma.

× 10. Glycerine.

This is from the opposite side of the same eyeball as Fig. 162. Numbers as in that figure.

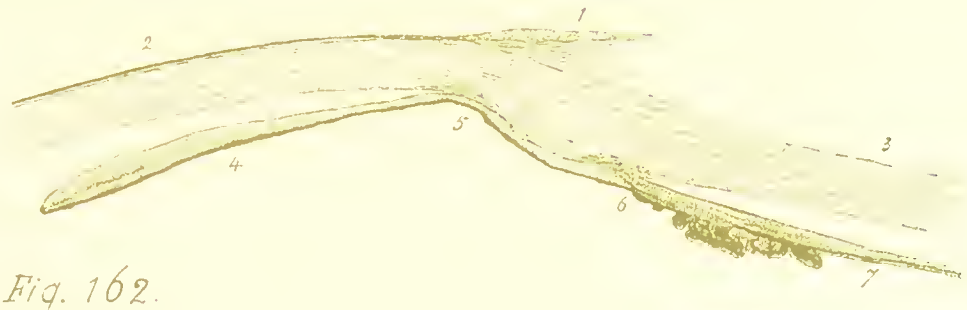

Fig. 162.

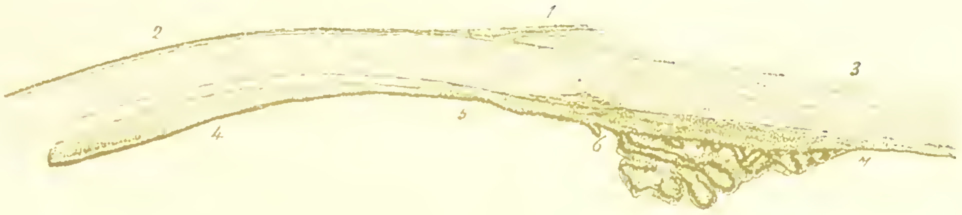

Fig. 163.

PLATE LXX.

Fig. 164.—Transverse Section of Optic Nerve.

× 10. Carmine, Dammar.

The section is taken behind the entrance of the central vessels.

1. Outer sheath. 2. Inter-vaginal space, with some fibres here and there. 3. Inner sheath. 4. Nerve fibres, in bundles of various sizes, separated by trabeculæ of fibrous tissue connected with the inner sheath.

Fig. 165.—Part of Transverse Section of Optic Nerve.

× 45. Carmine, Dammar.

Numbers as in Fig. 164. The axis cylinders of the nerve fibres are seen as red dots.

Fig. 166.—Part of Longitudinal Section of Optic Nerve.

× 45. Carmine, Dammar.

1. Inner sheath. 2. Trabeculæ, forming frame-work, dividing the nerve into bundles. 3. Bundles of nerve fibres.

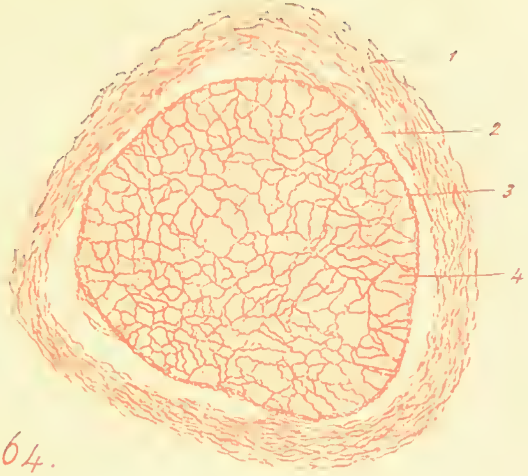

Fig. 164.

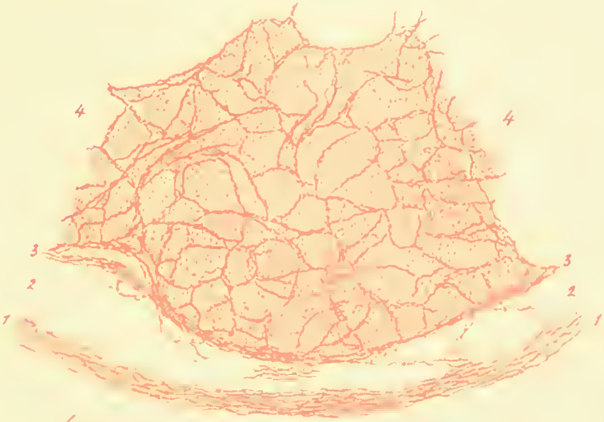

Fig. 165.

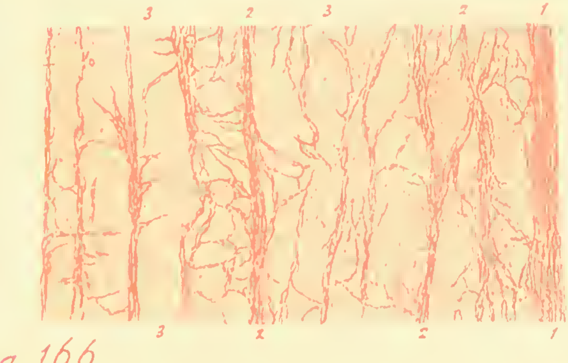

Fig. 166.

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Hatte & Runciman Glasgow Imp.

PLATE LXXI.

Fig. 167.—Part of Longitudinal Section of Optic Nerve with Interstitial Neuritis.

× 45. Logwood, Dammar.

1. Inner sheath, infiltrated with round cells, the nuclei of which are stained. 2. Trabeculæ, with many nuclei of inflammatory cells. 3. Bundles of nerve fibres, with some nuclei.

Fig. 168.—Transverse Section of Atrophied Optic Nerve.

× 10. Logwood, Dammar.

The margin is formed of the inner sheath; inside this there is a thick zone of dense cicatricial tissue replacing the nerve fibres, which have entirely disappeared; the centre is occupied by granular débris of nerve fibres, among which the remains of the central vessels are seen cut across.

Fig. 169.—Part of Transverse Section of Optic Nerve with Sarcoma.

× 45. Logwood, Dammar.

This is from the same case as Fig. 110.

1. Outer sheath. 2. Inner sheath. 3. Round-celled sarcoma distending the inter-vaginal space. 4. External layers of atrophied nerve, replaced by dense fibrous tissue, the bundles of which are cut across. 5. Granular mass, representing the degenerated central nerve fibres

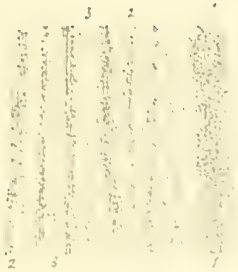

Fig. 167.

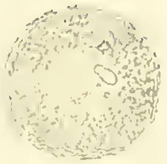

Fig. 168.

Fig. 169.

PLATE LXXII.

Fig. 170.—Vertical Section of Optic Disc and neighbouring parts.

× 30. Carmine, Dammar.

1. Optic nerve; the connective-tissue trabeculæ are more deeply stained than the bundles of nerve fibres. 2. Central vessels, passing forwards to centre of disc. 3. Inner sheath of nerve. 4. Outer sheath. 5. Sclerotic, with many blood-vessels. 6. Choroid. 7. Retina. 8. Centre of disc, with slight depression, between the somewhat raised margins.

Pl.XX.

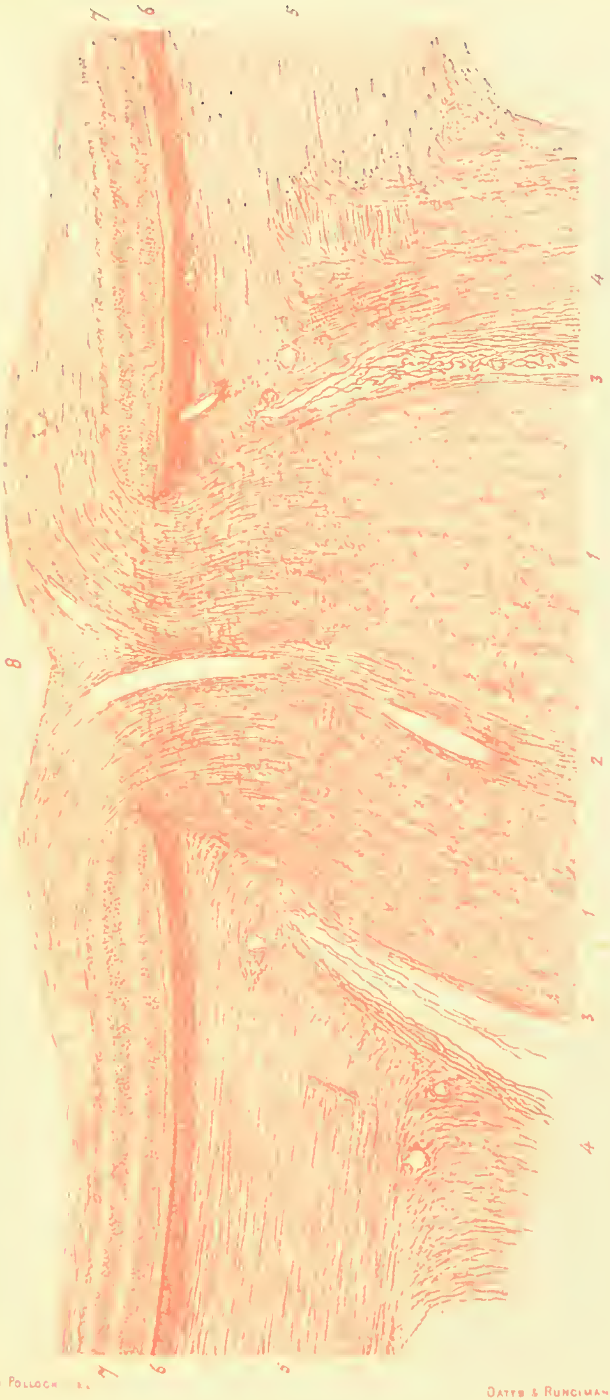

Fig. 170.

Fred Pollock del.

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PLATE LXXIII.

Fig. 171.—Vertical Section of Optic Disc.

× 10. Stained, Dammar

1. Optic nerve, with trabeculæ stained. 2. Central vessels. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic. 6. Choroid. 7. Retina. 8. Optic disc.

There is a deep physiological cup in the centre of the disc; and the central artery passes along the side of this. Pigmented cells are very numerous in the inner layers of the sclerotic near the lamina cribrosa.

Fig. 172.—Vertical Section of Optic Disc.

× 10. Glycerine.

Numbers as in Fig. 171.

In this specimen there is no physiological cup in the disc. The bundles of optic-nerve fibres appear very opaque, owing to the fatty nature of the medullary sheaths.

Pl. LXXIII

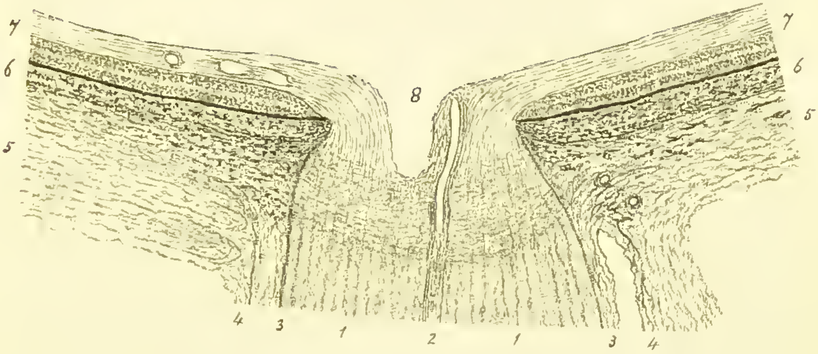

Fig. 171

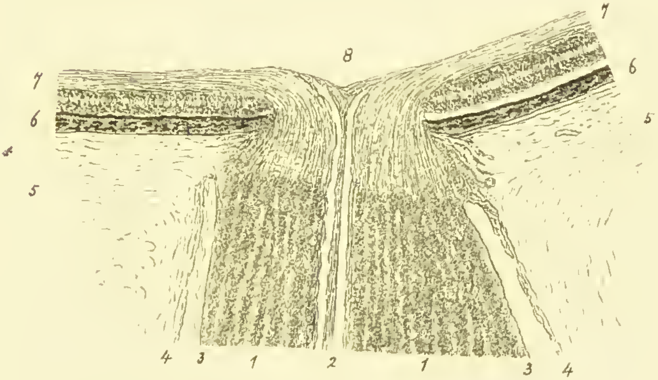

Fig. 172

C. Fred Pollock del.

Oatts & Runciman Glasgow, Imp.

PLATE LXXIV.

Fig. 173.—Vertical Section of Optic Disc with Papillitis.

× 30. Glycerine.

This is from a case of retinitis albuminurica.

1. Optic nerve. 2. Central vessels. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic. 6. Choroid. 7. Centre of swollen disc, with a few loose connective-tissue fibres on the surface. 8. Arteria centralis retinæ, passing to the side, and surrounded with inflammatory cells. 9. Nerve-fibre layer at margin of disc, œdematous and greatly thickened. The other retinal layers are pushed away from the edge of the opening in the choroid, and the pigmented epithelium is wanting in the same region. 10. Retina. 11. Coagulated granular material, containing pigmented cells, between the choroid and the slightly detached retina.

Pl. LXXIV

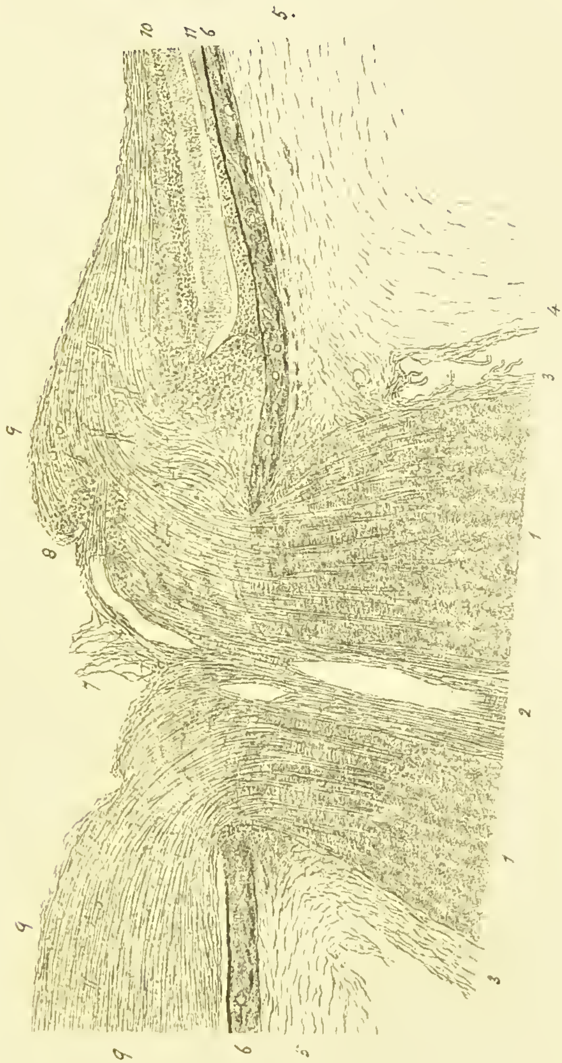

Fig. 143.

C. Fred Pollock, del.

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PLATE LXXV.

Fig. 174.—Vertical Section of Optic Disc with Neuro-retinitis.

× 30. Glycerine.

This is from the same case as Fig. 77.

1. Optic nerve. 2. Central vessels; the sheath of the artery is distended with an accumulation of inflammatory round cells. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic, with large blood-vessels. 6. Choroid. 7. Outer layers of retina, slightly detached, and forming wavy folds. Some granular sub-retinal material is still present on the left side. 8. Nerve-fibre layer of retina. 9. Collection of round cells in the greatly thickened retina (retinitis). 10. Centre of swollen disc. 11. Infiltration with inflammatory cells, extending deeply into disc (papillitis).

PL. LXV

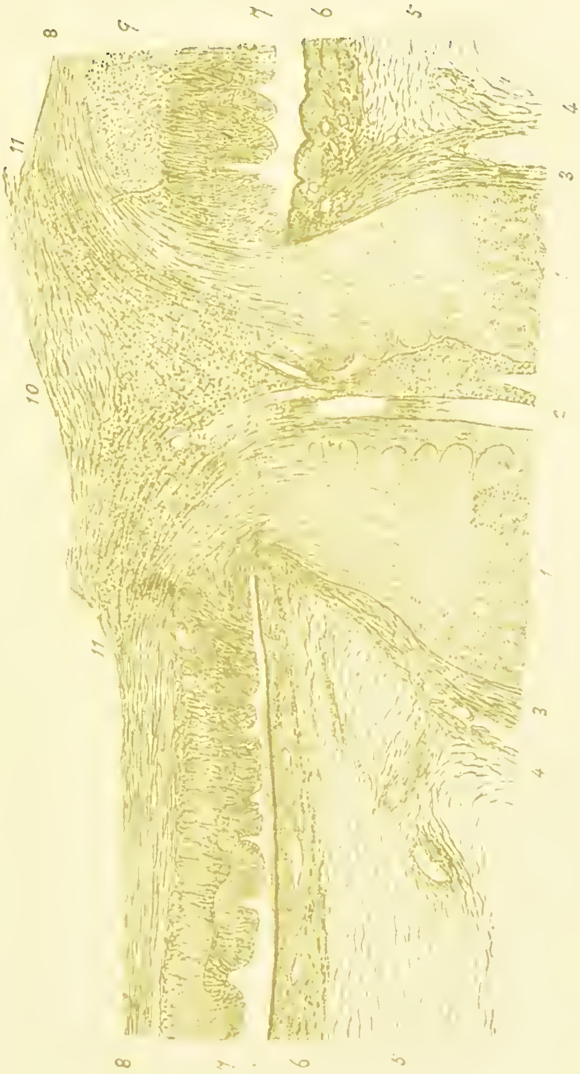

Fig. 174.

F. Fred Pollock del.

Oatts & Runciman Glasgow, lith.

PLATE LXXVI.

FIG. 175.—Vertical Section of Atrophied Optic Disc and neighbourhood with Choroido-retinitis.

× 10. Carmine, Glycerine.

This is from an eye, in which inflammatory attacks during many years had led to extensive changes, in addition to those drawn in the figure. The cornea was opaque and vascular; and the anterior two-thirds of the globe were occupied by a firm organized fibrous mass, attached to the remains of the ciliary body and the adjacent part of the choroid, and passing through the pupil to be united to the central portion of the cornea, near which the curled-up capsule of the lens was embedded in the mass. The iris, infiltrated with round cells, thickened and distorted, was adherent to the cornea in front and to the cyclitic formation behind, the uvea being much broken up and detached. The anterior chamber was very shallow; but its angle was free and open. The ciliary body contained groups of inflammatory cells, and was enlarged and spongy, its internal outline being lost in the attached membrane, and the ciliary muscle being drawn towards the centre of the eyeball. Between the fibrous formation and the disc there was a space, bounded by a thick membrane replacing the retina and choroid; and the almost complete absence of pigment about the fundus was noticeable.

1. Optic nerve. 2. Centra vessels. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic. 6. Inflammatory membrane, composed of fibres and cells, containing traces of the choroid. 7. In this part of the membrane some retinal elements were scattered about. 8. Choroid and retina replaced by a thick membrane, in which some of their tissues were distinguishable with a higher power. 9. Atrophied disc. 10. Delicate connective tissue, in front of the more dense layer.

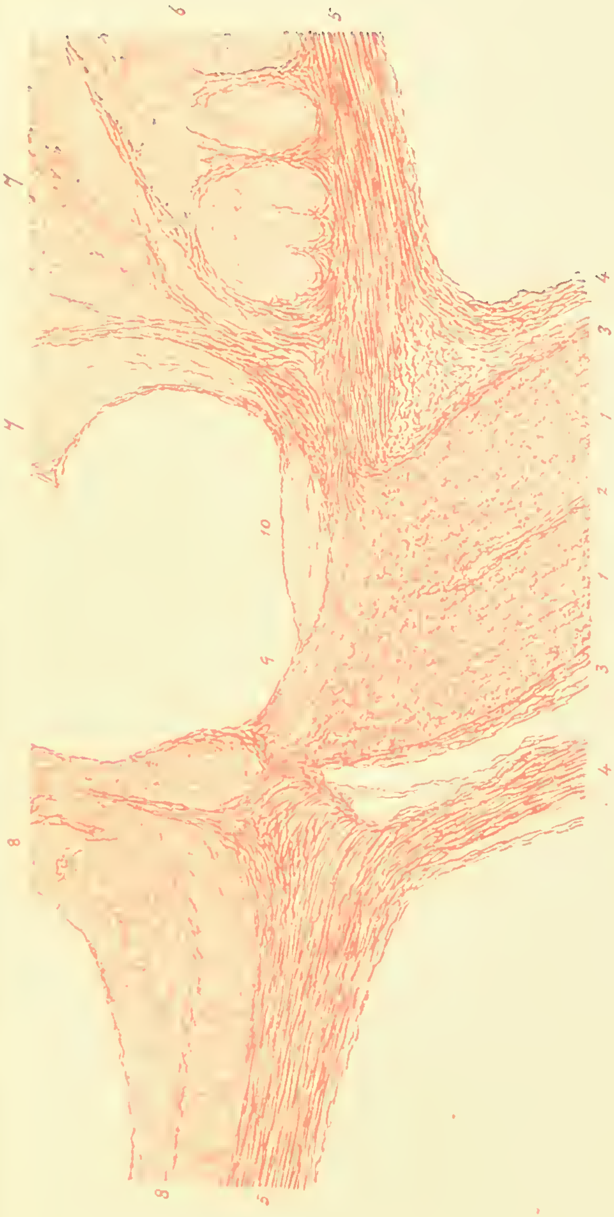

Fig. 175.

C. Fred Pollock del.

Oatts & Runciman, Glasgow, Imp.

PLATE LXXVII.

Fig. 176.—Vertical Section of Optic Disc with Œdema.

× 10. Stained, Dammar.

1. Optic nerve. 2. Central vessels. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic. 6. Choroid. 7. Retina. 8. Centre of swollen disc. 9. Prominent margins of disc. The nerve-fibre layer is œdematous, forming a loose spongy tissue. The retina and the pigmented epithelium are pushed aside from the edge of the disc by the swelling; and some granular material, containing detached pigmented cells, intervenes between the retina and the choroid.

Fig. 177.—Vertical Section of Optic Disc with Vascular Connective-tissue Growth.

× 10. Glycerine.

This is from a woman, twenty years of age. A year before removal, the right eye was affected with an "inflammatory attack." It remained irritable and troublesome, with occasional pain; but increased tension was not observed till a month before enucleation, at which time there were areas of opacity in the cornea and discoloration of the iris. The condition of the ciliary region is shown in Figs. 162 and 163.

1. Optic nerve. 2. Central vessels. 3. Sheaths of nerve. 4. Sclerotic. 5. Retina and choroid, united, atrophied, and forming a pigmented membrane. 6. Growth, projecting from atrophied disc, consisting of delicate fibres running in various directions, large thin-walled blood-vessels, knots of smaller vessels with fine walls, collections of pigmented cells, and masses of pigment. There are large spaces, and some of these were filled with granular or finely fibrillated material. 7. Membranous extension from growth, composed of fibrous tissue with pigmented cells, spreading over retina, to the surface of which a similar membrane is seen adhering on the other side of the disc.

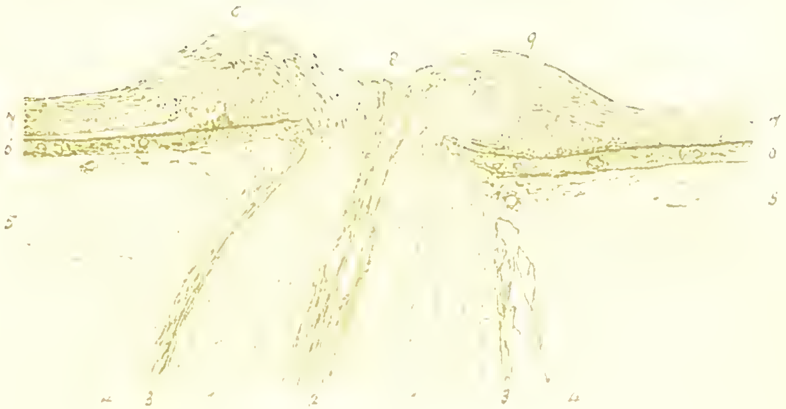

Fig. 176.

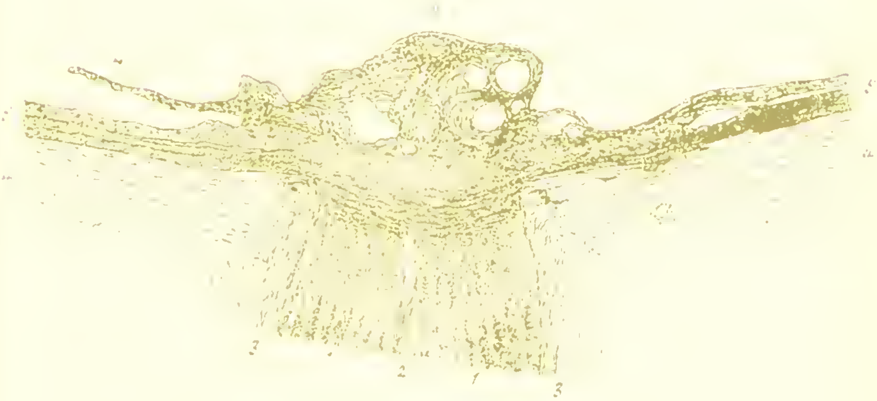

Fig. 177.

PLATE LXXVIII.

FIG. 178.—Vertical Section of Optic Disc in Glaucoma.

× 10. Stained, Dammar.

This is from the same case as Fig. 155.

1. Optic nerve, with the connective-tissue frame-work deeply stained. 2. Central vessels. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic. 6. Choroid, atrophied and thin. 7. Retina. It is partially atrophied, and the layer of nerve fibres is thin. 8. Retina. At this side it is considerably atrophied; but appears thickened, owing to œdematous spaces in the internal nuclear layer. 9. Deep glaucomatous excavation of the disc.

FIG. 179.—Vertical Section of Margin of Optic Disc in Glaucoma.

× 10. Glycerine.

This is from the same disc as Fig. 178.

1. Optic nerve, with dark bundles of nerve fibres. 2. Inner sheath. 3. Outer sheath. 4. Sclerotic. 5. Choroid, atrophied and forming a thin pigmented membrane. 6. Retina, somewhat atrophied. 7. Partially atrophied retina, with œdema. 8. Section of overhanging edge of excavated disc. The tissue in the centre is a thin membrane with delicate fibres; at both sides it contains some nerve fibres; and at the left side there are indications of blood-vessels. 9. Posterior part of glaucomatous excavation of disc, under the anterior overhanging edge. The sides and floor of the excavation are markedly fibrous.

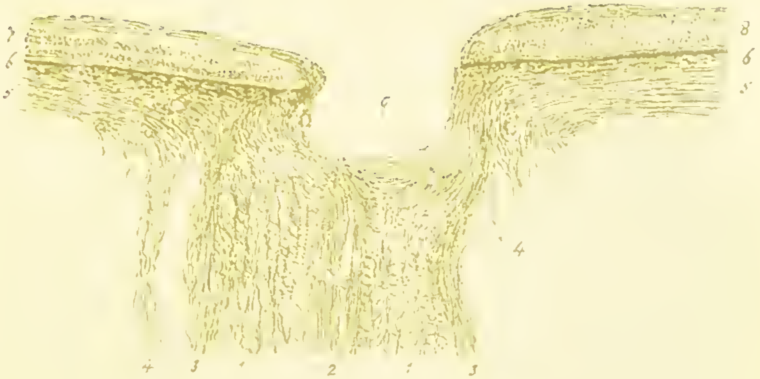

Fig. 178.

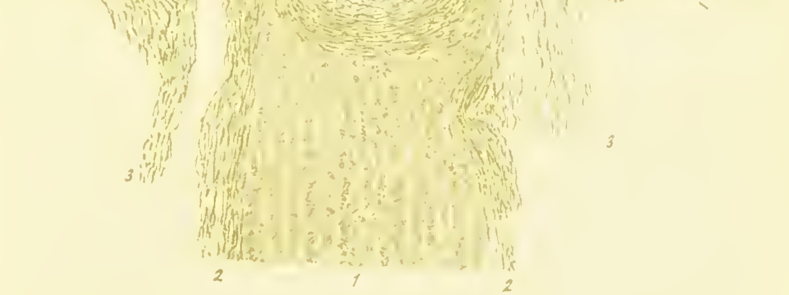

Fig. 179.

C. Fred Pollock del.

atts & Runciman Glasgow.

PLATE LXXIX.

Fig. 180.—Vertical Section of Optic Disc in Glaucoma.

× 30. Carmine, Dammar.

This is from the right eye of a woman, sixty-nine years of age, which had been affected for six months before enucleation. The condition of the cornea is shown in Fig. 44, and of the angle of the anterior chamber in Fig. 158.

1. Optic nerve. 2. Central vessels, with thick adventitia. 3. Inner sheath. 4. Outer sheath. 5. Sclerotic. 6. Retina. This is thinned; but all the layers can be recognized with a higher power. 7. Retina, somewhat atrophied at this side. 8. Deep glaucomatous excavation of disc, the floor of which is composed of connective tissue. 9. The lamina cribrosa is greatly thickened by a formation of dense fibrous tissue. The choroid surrounding the disc was represented by a thin fibrous layer with some granules of pigment.

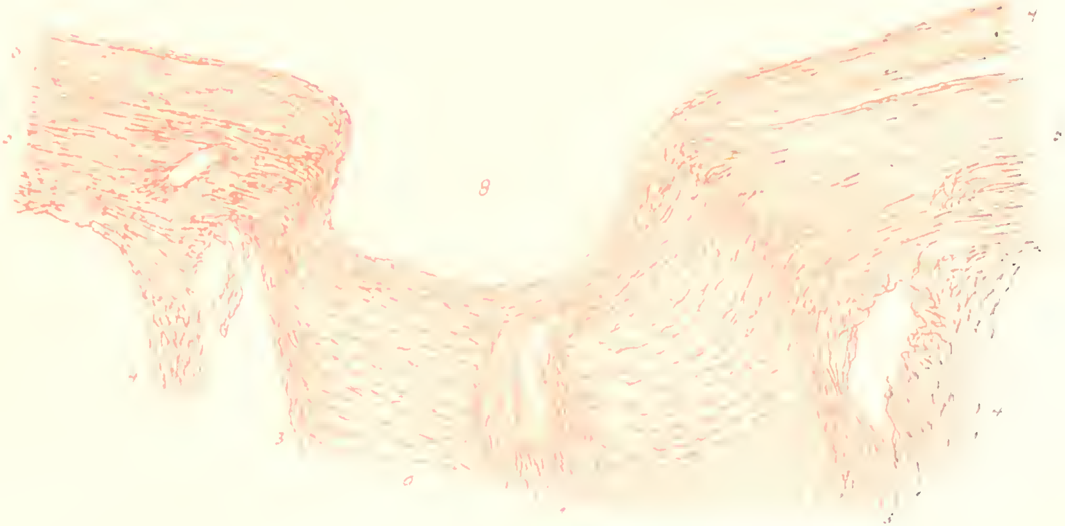

Fig. 180.

PLATE LXXX.

Fig. 181.—Vertical Section of Retina.

× 300. Glycerine.

This is about 3 millimètres from the edge of the optic disc.

Layers as follows:—1. Membrana limitans interna, from which the fibres of Müller extend vertically. 2. Nerve fibres. 3. Large vessel with blood corpuscles. 4. Nerve cells. The tissue is very loose at this part. 5. Internal molecular. A capillary vessel is present here. 6. Internal nuclear. 7. External molecular. 8. External nuclear. 9. Membrana limitans externa. 10. Rods and cones. Only indications of these can be seen.

Fig. 182.—Vertical Section of Retina near Periphery.

× 300. Glycerine.

This is about 2 millimètres behind the ora serrata; from same eye as Fig. 181.

Layers as follows:—1. Membrana limitans interna. 2. Nerve-fibres. 3. Internal molecular. 4. Internal nuclear. 5. External molecular. 6. External nuclear. 7. Membrana limitans externa. 8. Rods and cones.

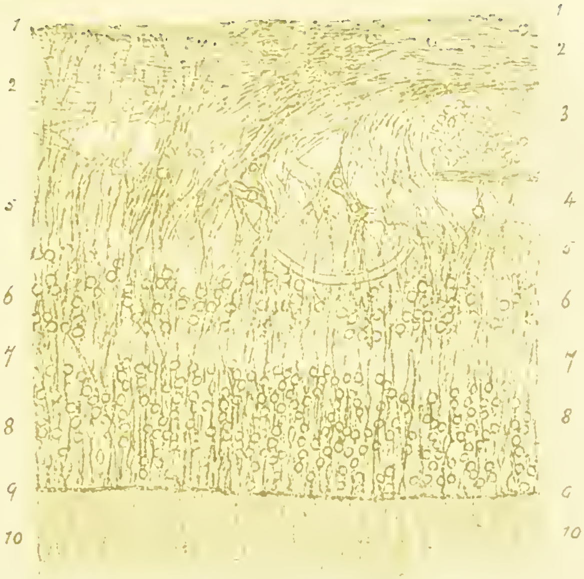

Fig. 181.

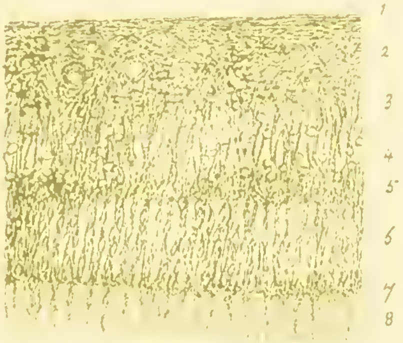

Fig. 182.

Fred Pollock, del.

Watts & Runciman, Glasgow, Imp.

PLATE LXXXI.

Fig. 183.—Vertical Section of Retina.

× 300. Glycerine.

This is about 5 millimètres from the edge of the optic disc.

Layers as follows:—1. Membrana limitans interna, from which the fibres of Müller extend vertically in bundles. 2. Nerve fibres. 3. Nerve cells. 4. Internal molecular. 5. Internal nuclear. 6. External molecular. 7. External nuclear, with well-marked inner fibrous portion. 8. Membrana limitans externa. 9. Rods and cones, not well preserved. 10. Pigmented epithelium.

Fig. 184.—Vertical Section of Retina near Disc.

× 45. Glycerine.

Layers as follows:—1. Nerve fibres, cut transversely, divided into bundles by the connective-tissue frame-work. A large vessel and some smaller ones are cut across. 2. Internal molecular. 3. Internal nuclear. 4. Fibrous portion of external nuclear. 5. External nuclear. 6. Rods and cones.

Fig. 185.—Internal Surface of Retina.

× 300. Silver, Glycerine.

The dark lines are produced by the staining with silver.

Fig. 186.—Vertical Section of Macula Lutea.

× 45. Glycerine.

Layers as follows:—1. Nerve fibres. 2. Internal molecular. 3. Internal nuclear. 4. External molecular and inner fibrous portion of the next layer. 5. External nuclear. 6. Rods and cones. The fovea centralis is in the middle of the figure, where the layers are thinned.

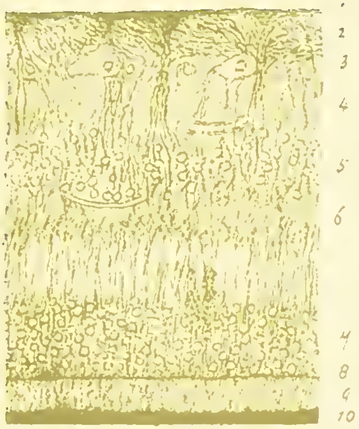

Fig. 183.

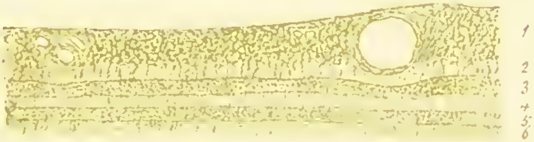

Fig. 184.

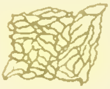

Fig. 185.

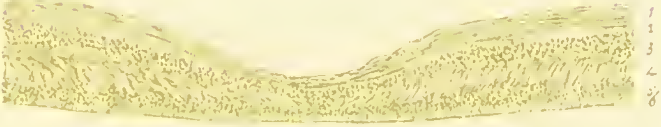

Fig. 186.

Fred Pollock del.
Oatts & Runciman Glasgow lith

PLATE LXXXII.

Fig. 187.—Vertical Section of Macula Lutea.

× 200. Glycerine.

Retinal layers as follows:—1. Membrana limitans interna. 2. Nerve fibres and internal molecular. 3. Internal nuclear. 4. External molecular and inner fibrous portion of next layer. 5. External nuclear. 6. Rods and cones. In the middle of the figure is the fovea centralis, and the neighbouring radial fibres have a slanting direction towards this point.

Fig. 187.

C. FRED P[illegible]OCK DEL.

[illegible] RUNCIMAN [illegible]

PLATE LXXXIII.

Fig. 188.—Vertical Section of Retina.

× 300. Logwood, Dammar.

This is about 4 millimètres from the edge of the optic disc. Layers as follows:—1. Membrana limitans interna, from which the fibres of Müller extend vertically. 2. Nerve fibres. 3. Nerve cells. 4. Internal molecular. 5. Internal nuclear. 6. External molecular. 7. External nuclear. 8. Membrana limitans externa. 9. Rods and cones, an indistinct granular mass.

Fig. 189.—Vertical Section of Retina near Disc.

× 45. Logwood, Dammar.

Layers as follows:—1. Membrana limitans interna. 2. Nerve fibres. 3. Nerve cells. A blood-vessel is present here. 4. Internal molecular. 5. Internal nuclear. 6. External molecular and inner fibrous portion of the next layer. 7. External nuclear. 8. Membrana limitans externa. 9. Rods and cones.

Fig. 190.—Vertical Section of Retina with Œdema.

× 45. Logwood, Dammar.

Layers as follows:—1. Membrana limitans interna. 2. Nerve fibres. 3. Internal nuclear. 4. External molecular and fibrous portion of the next layer. 5. External nuclear. 6. Rods and cones. Towards the left side of the figure the retina is normal; about the middle both the internal and the external nuclear layers are affected and thickened, containing empty spaces; at the right side only the internal nuclear layer is affected, being greatly thickened, and having its elements separated by large spaces.

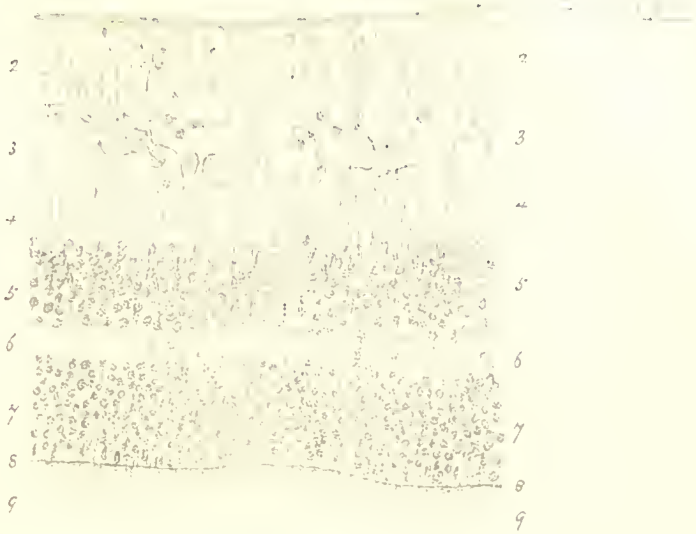

Fig. 188.

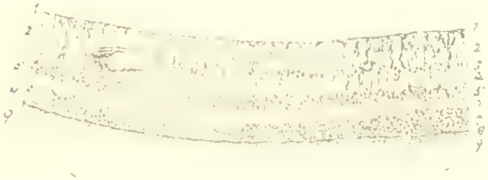

Fig. 189.

Fig. 190.

PLATE LXXXIV.

Fig. 191.—Vertical Section of Retina with Œdema.

× 300. Glycerine.

Layers as follows:—1. Membrana limitans interna, from which fibres of Müller pass vertically. 2. Nerve fibres. 3. Nerve cells and internal molecular. 4. Internal nuclear, greatly thickened and containing large empty spaces. The fibres passing through it are very distinct, and form bundles between the spaces; and the nuclei are embedded among the fibres in fusiform thickenings. 5. External molecular. 6. External nuclear. 7. Membrana limitans externa. 8. Rods and cones.

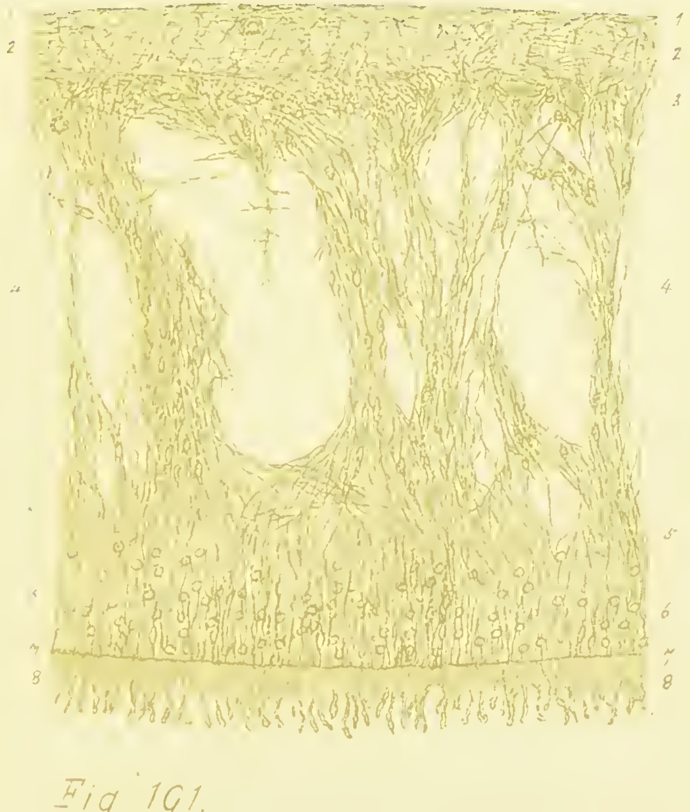

Fig. 191.

[illegible]

Oatts & Runciman Glasgow Imp.

PLATE LXXXV.

FIG. 192.—Vertical Section of Retina near Ora Serrata with Cystic Degeneration.

× 45. Glycerine.

This is from an eye with chronic glaucoma.

1. Internal surface. 2. External surface. None of the normal structure can be distinguished. The retina is split by a large cavity into two layers of fibrous tissue, and in each of these numbers of empty spaces occur.

FIG. 193.—Vertical Section of Retina near Ora Serrata with Cystic Degeneration.

× 300. Glycerine.

This is from the same eye as Fig. 192.

1. Internal surface. 2. External surface. Numerous small cysts are seen as empty spaces among fibrous tissue, and between the two main layers part of a large cavity intervenes. One of the cysts contains amorphous granular material; towards the outer surface some of the nuclear elements are present.

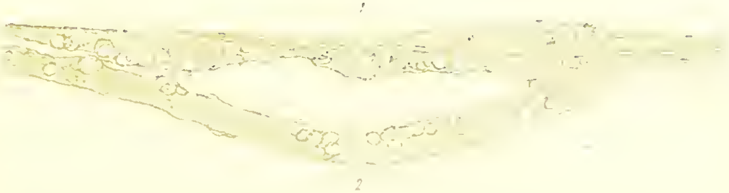

Fig. 192.

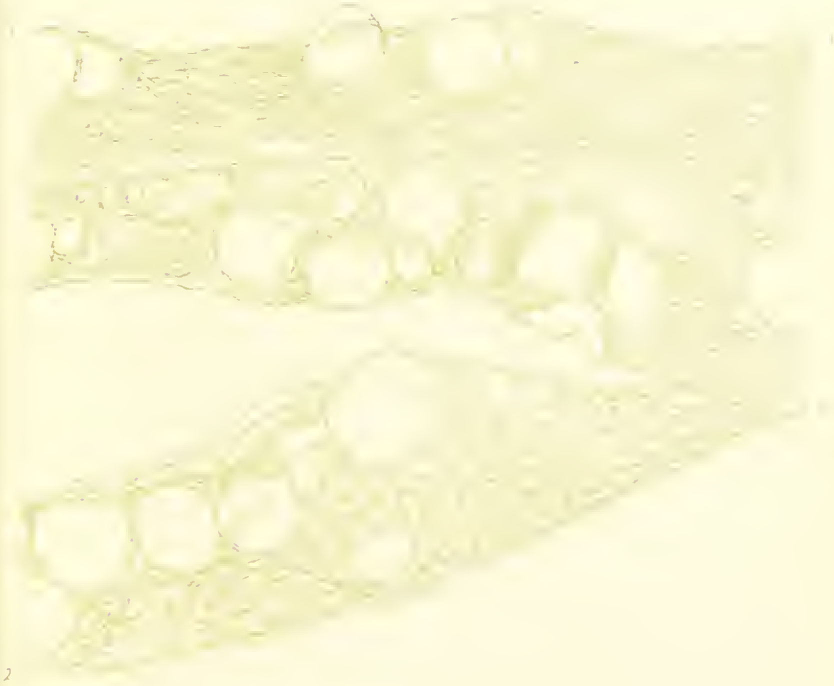

Fig. 193.

[illegible] & Runciman [illegible]

PLATE LXXXVI.

Fig. 194.—**Vertical Section of Retina with Retinitis Albuminurica.**

× 300. Glycerine.

Layers as follows:—1. Membrana limitans interna, from which the fibres of Müller pass vertically. 2. Nerve fibres. 3. Internal molecular. 4. Internal nuclear. 5. External molecular. 6. External nuclear. The rods and cones are absent. The internal nuclear and external molecular layers are much altered, and contain compound granular corpuscles and large granular masses, some of which have a nucleus, lying in spaces between bundles of vertical fibres. One or two similar masses occur in the internal molecular layer. Portions of two capillaries are very prominent.

Fig. 195.—**Vertical Section of Retina with Retinitis Albuminurica.**

× 300. Glycerine.

Layers as follows:—1. Membrana limitans interna. 2. Nerve fibres, cut transversely. 3. Nerve cells. 4. Internal molecular. 5. Internal nuclear. 6. External molecular. 7. External nuclear. 8. Membrana limitans externa. 9. Rods and cones, not well preserved. 10. Pigmented epithelium.

In the external molecular layer there are large round granular masses and prominent capillaries. In the nerve-fibre layer there is a blood-vessel, cut transversely, and surrounded by an infiltration of inflammatory round cells (peri-vasculitis); this has displaced the adjacent layers somewhat, and the nerve cells are absent locally.

PL.

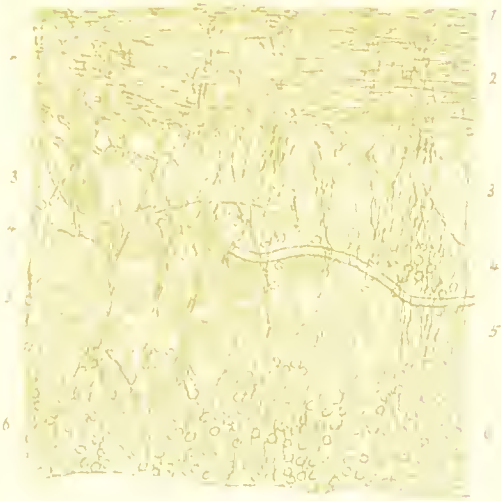

Fig. 194

Fig 195.

FRED P

PLATE LXXXVII.

Fig. 196.—**Vertical Section of Retina with Retinitis Albuminurica.**

× 300. Glycerine.

Layers as follows :—1. Membrana limitans interna. 2. Nerve fibres, cut across, divided into bundles by the connective-tissue frame-work. A transverse section of an artery is present in this layer, with thickened clear walls (sclerosis). At the outer part of this layer there is a longitudinal section of a blood-vessel with thick walls. 3. Nerve cells. 4. Internal molecular. 5. Internal nuclear. 6. External molecular. 7. External nuclear. 8. Membrana limitans externa. The rods and cones are not preserved.

Fig. 197.—**Vertical Section of Retina with Plastic Retinitis.**

× 300. Glycerine.

This is from an eye enucleated fifteen days after a wound in the corneo-scleral region.

Layers as follows :—1. Membrana limitans interna. 2. Nerve fibres. This layer is thickened with an infiltration of inflammatory round cells. 3. Internal molecular. 4. Internal nuclear. 5. External molecular. 6. External nuclear. 7. Membrana limitans externa. 8. Rods and cones, not well preserved.

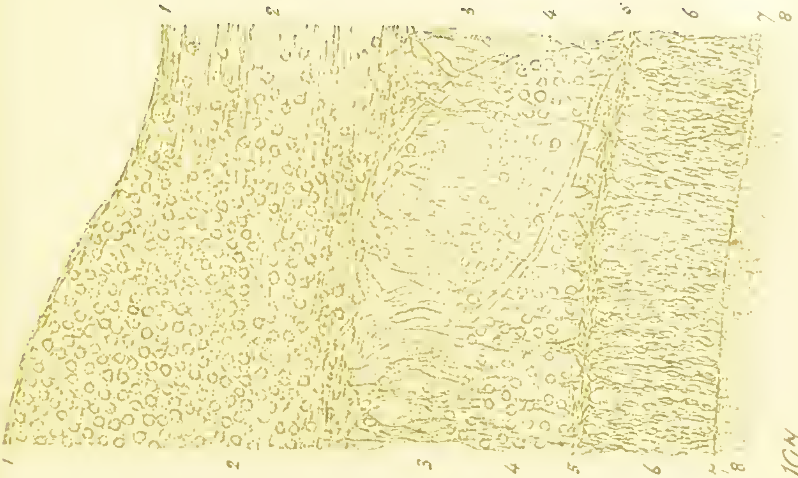

Fig. 197.

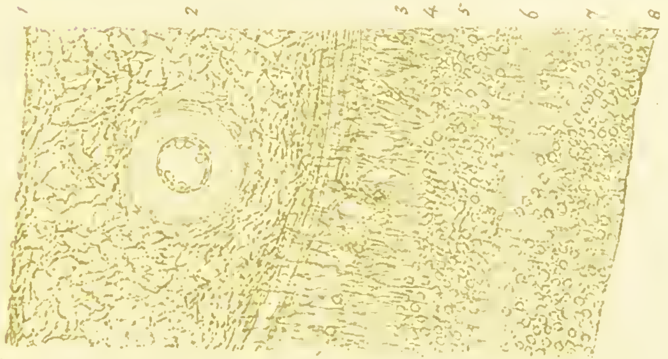

Fig. 196.

Thos. Pollock del.

Watts & Runciman Glasgow

PLATE LXXXVIII.

FIG. 198.—Vertical Section of Retina with Plastic Retinitis.

× 45. Glycerine.

This is from the same case as Fig. 197.

Layers as follows :—1. Nerve fibres. At the left side this layer is greatly thickened, and has a copious infiltration with inflammatory cells. 2. At this point the retina ceases to be affected. 3. Internal molecular. 4. Internal nuclear. 5. External molecular. 6. External nuclear. 7. Membrana limitans externa. 8. Rods and cones.

FIG. 199.—Vertical Section of Atrophied Retina.

× 45. Glycerine.

This is from a case of chronic glaucoma.

1. Internal surface. 2. External surface with pigmented epithelium. At each end of the figure the atrophy is very great, the retina being reduced to a thin fibrous membrane; and even in the central portion it is well advanced, although indications of different layers can be distinguished.

Pl. LXXXVIII

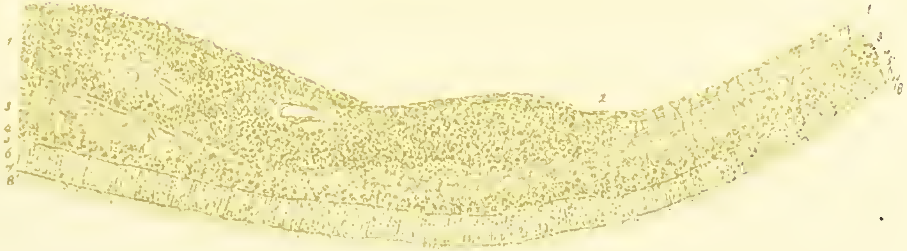

Fig. 198.

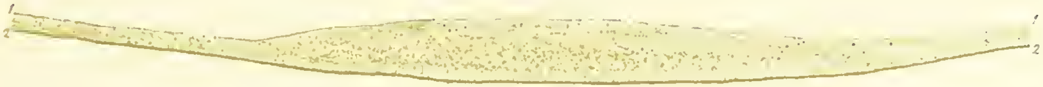

Fig. 199.

Fred. Po[illegible]

Oatts & Runciman Glasgow Imp.

PLATE LXXXIX.

FIG. 200.—Vertical Section of Atrophied Retina.

× 300. Glycerine.

The thickness of the retina is greatly diminished, and the inner layers are replaced by fibrous tissue.

1. Membrana limitans interna, much thickened. 2. Nerve-fibre layer, chiefly fibrous tissue, in the midst of which a denser portion indicates an obliterated blood-vessel. The outer layers are thin; but their remains can still be distinguished as follows:—3. Internal molecular. 4. Internal nuclear. 5. External molecular. 6. External nuclear. 7. Membrana limitans externa.

FIG. 201.—Vertical Section of Atrophied Retina.

× 300. Glycerine.

This portion of retina shows very advanced atrophy. 1. Membrana limitans interna. 2. The inner layers are replaced by a stratum of fibrous tissue, with a dense cord representing an obliterated blood-vessel. 3. The outer layers are quite indistinguishable, and their position is occupied by granular material and interlacing fibres.

FIG. 202.—Pigment in Detached and Atrophied Retina.

× 300. Stained, Dammar.

This is from the same eye as Fig. 203, and from a position near No. 7 of that figure.

There are elongated and round nuclei, stained, among fibrous tissue. The deposit of pigment was in the form of dark brown granules of various sizes in loose roundish collections and in large cells, some of which were nucleated.

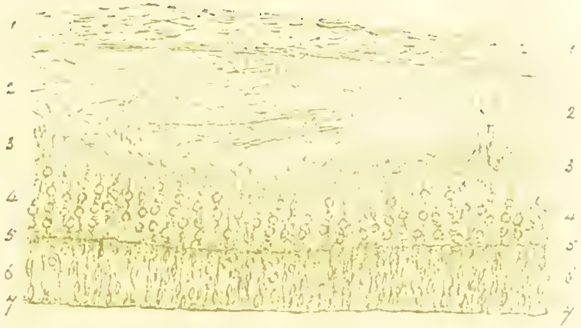

Fig. 200.

Fig. 201.

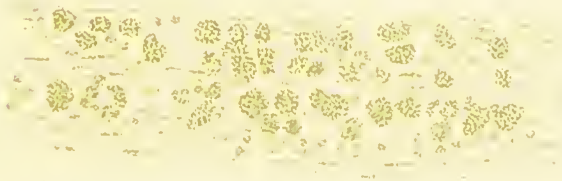

Fig. 202.

C. Fred Pollock, del. [illegible]

PLATE XC.

Fig. 203.—Vertical Section of Optic Disc with Detached Retina.

× 10. Stained, Dammar.

For the history of the case see Fig. 215.

1. Optic nerve; the connective-tissue frame-work is stained. 2. Inner sheath. 3. Outer sheath. 4. Sclerotic. 5. Choroid. 6. Remains of retina, passing forwards as a fibrous cord from the centre of the disc. It spread out anteriorly, and was attached about the ora serrata. Portions of the central vessels are present. 7. At this place there was a deposit of pigment continuous with the adjacent choroid. The disc appears dragged forwards; and the inner layers of the choroid extend over the retinal cord.

Fig. 204.—Vertical Section of Optic Disc with Detached Retina.

× 10. Glycerine.

For the history of the case see Fig. 137.

1. Optic nerve. 2. Inner sheath. 3. Outer sheath. 4. Sclerotic. 5. Choroid. 6. Remains of retina, passing forwards from the disc. 7. At this point the retina became funnel-shaped; the periphery was attached at the ora serrata.

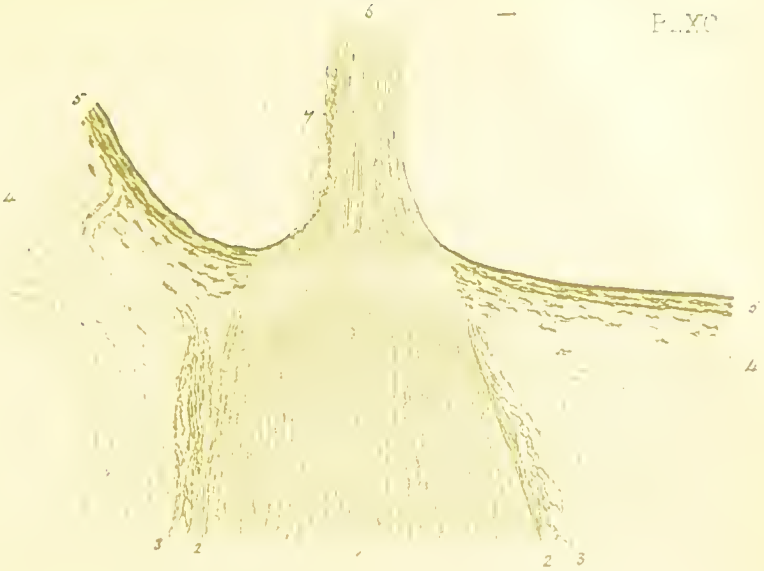

Fig. 203.

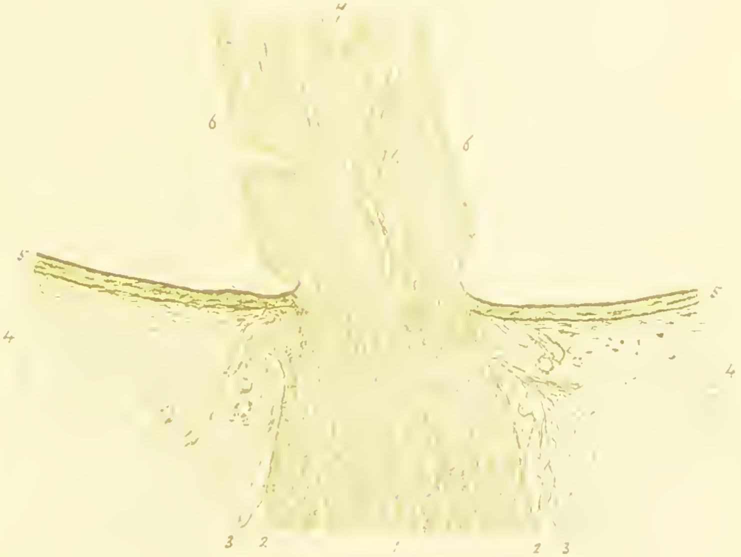

Fig. 204.

Fred Pollock del.

Oatts & Runciman Glasgow lith.

PLATE XCI.

Fig. 205.—Vertical Section of Atrophied and Pigmented Retina.

× 300. Glycerine.

The retina is greatly reduced in thickness, and is converted into a loose fibrous net-work, in which masses of pigment, pigmented cells, and scattered free granules of pigment are embedded.

1. The membrana limitans interna, connected with the radiating fibres of Müller. 2. In the inner layers the direction of the fibres is more or less parallel with the surface. 3. The outer layers are indicated by nuclei distributed throughout the tissue, which is loose and irregular in its arrangement. 4. Some of the pigmented epithelium is still present in its normal position. 5. The atrophied choroid forms a thin band of dense fibrous tissue with some pigment.

Fig. 206.—Vertical Section of Choroid and Retina after Choroido-retinitis.

× 45. Glycerine.

1. At this place retinal elements are present, level with the choroid, with which they are incorporated; large masses of pigment surround them. 2. Inner surface of choroid. 3. Outer surface of choroid. The choroid is atrophied and very fibrous; the normal pigment is wanting; and large empty vessels are seen, cut across.

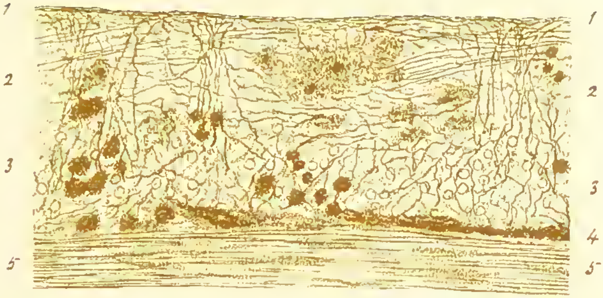

Fig. 205.

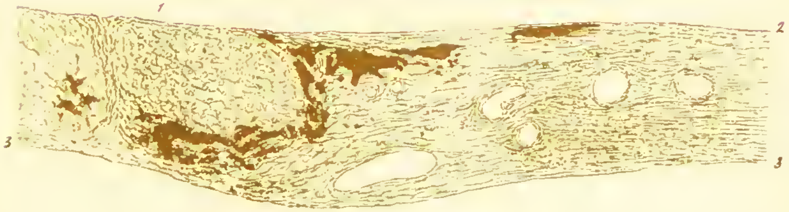

Fig. 206.

C Fred Pollock del

Maclure & Macdonald, Glasgow, Imp

PLATE XCII.

Fig. 207.—Vertical Section of Retina and Choroid with Accumulation of Pigmented Epithelium.

× 300. Glycerine.

Layers of retina as follows:—1. Membrana limitans interna. 2. Nerve fibres. 3. Nerve cells. 4. Internal molecular. 5. Internal nuclear. 6. External molecular. 7. External nuclear, with well-marked inner fibrous portion. 8. Membrana limitans externa. 9. Rods and cones. 10. Pigmented epithelium. From this there is a small nodular out-growth, which has destroyed the rods and cones and displaced the external nuclear layer locally. 11. The choroid is atrophied, and forms a thin fibrous layer, with lines of pigment.

Fig. 208.—Section at Margin of Glioma Retinæ.

× 300. Glycerine.

1. Round granular nucleated cells of glioma, invading the external molecular layer of the retina. 2. Part of the external nuclear layer.

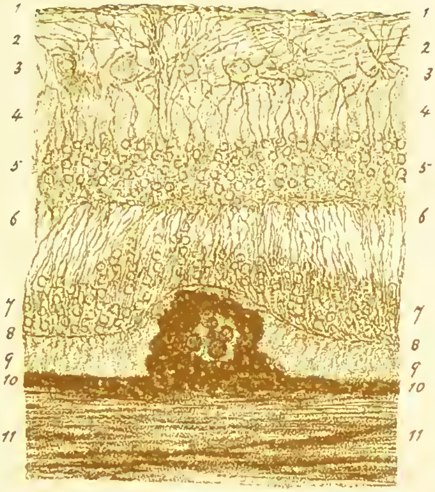

Fig. 207.

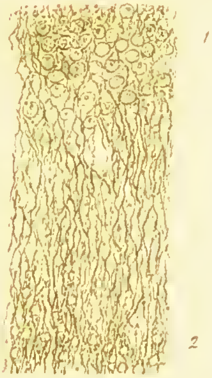

Fig. 208.

C. Fred. Pollock del.

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PLATE XCIII.

FIG. 209.—Vertical Section of Periphery of Retina with Glioma.

× 45. Logwood, Dammar.

I. is continuous with II.; A. is the most posterior part; B. is directly continuous with C.; D. is the most anterior part, near the ora serrata. The retina was folded and thickened by the growth advancing from the fundus.

1. Internal surface. 2. External surface, with granular traces of the rods and cones at some places. 3. Anterior border of main tumour, which involved the whole of the retina at the fundus. Nearer the periphery than this there is an interval, where the retina is unaffected. Then at 4 comes a nodule of glioma, quite separate from the main tumour, involving all the retinal layers, which are replaced by its tissue, though the external nuclear layer is at one part unchanged, and can be everywhere distinguished. At 5 some gliomatous tissue, detached from a softened part of the primary growth, lies on the inner surface of the retina, and some cells are present about a blood-vessel in the nerve-fibre layer. The nuclear layers are no longer distinct from one another. At 6 a similar condition of the nerve-fibre layer occurs, with some cells nearer the outer surface. At 7 the inner layers are diffusely affected. In the neighbourhood of 8 the internal nuclear layer is the only one changed, or is chiefly affected. Near 9 all the layers contain some cells. 10. This marks the extreme anterior margin of the gliomatous infiltration, in the external nuclear layer.

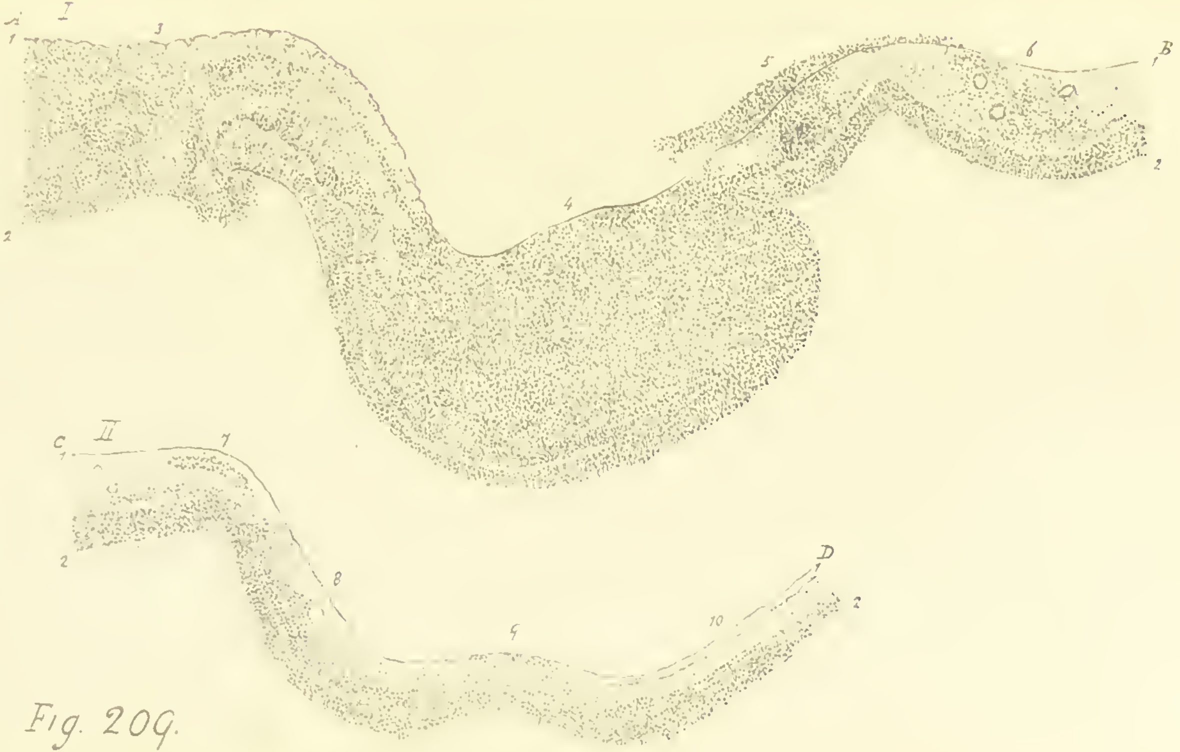


Fig. 209.

PLATE XCIV.

FIG. 210.—Capsule of Lens with Epithelium and Fibres of Zonula.

× 300. Stained, Glycerine.

This is from the anterior segment of the capsule.

1. Portion of transparent homogeneous capsule. 2. Epithelial cells, lining the internal surface. 3. Fibres of zonula of Zinn, passing to the external surface, on which they are lost.

FIG. 211.—Epithelium from Capsule of Lens.

× 300. Silver, Glycerine.

The intercellular substance is stained by the silver; a nucleus is visible in some of the cells.

FIG. 212.—Vertical Section of Capsule of Lens.

× 300. Glycerine.

I. is from near the anterior pole; II. nearer the margin; and III. near the equator.

1. Capsule. 2. Epithelium, lining the internal surface.

FIG. 213.—Vertical Section of Anterior Layers of Lens.

× 300. Stained, Dammar.

1. Capsule. 2. Epithelium. 3. Fibres of lens, some with a nucleus.

FIG. 214.—Portions of Fibres of Lens.

× 300. Glycerine.

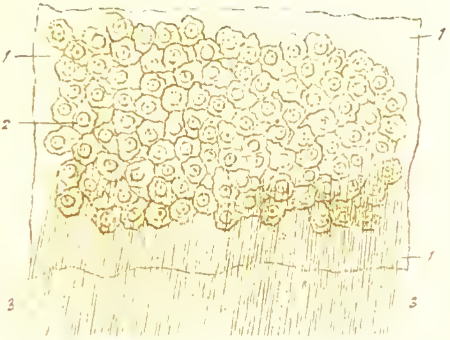
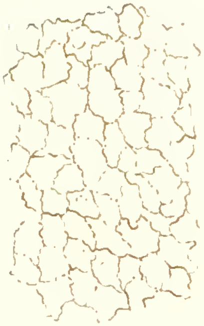


Fig. 210.



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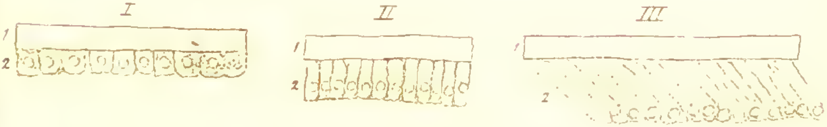

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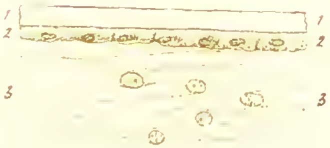

Fig. 213.

Fig. 214.

[illegible] Pollock del.

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PLATE XCV.

Fig. 215.—Anterior portion of Eyeball with Wound of Cornea, Iris, and Lens.

× 10. Glycerine.

This is from a man, thirty-six years of age. Fifty-three days before the enucleation of the eyeball a fragment of iron passed through the upper part of the cornea, iris, and lens, and lodged in the vitreous behind the lower part of the lens. The injury led to irido-cyclitis and softening of the globe. The condition of the optic disc is seen in Fig. 203.

1. Conjunctiva. 2. Sclerotic. 3. Cornea. 4. Cicatrix of wound in cornea; Bowman's membrane is interrupted and the anterior epithelium is thickened here. 5. Iris; the pupillary margin is adherent to the cornea at the cicatrix (synechia anterior), and to the capsule of the lens (synechia posterior). 6. Peripheral portion of iris, near wound. 7. Remains of uvea in inflammatory exudation. 8. Ciliary body, detached and dragged inwards. 9. Loose tissue, between ciliary muscle and sclerotic. 10. Choroid, detached. 11. Cyclitic membrane, composed of delicate fibres and many cells, with blood-vessels and traces of zonula. 12. Portions of lens; only some cortical fibres and the capsule are left in the preparation. The wound divides the lens into two parts. 13. Coagulated material, inside capsule. 14. Mass of inflammatory exudation in the path of the wound; it is continuous with the wounded iris in front, and with the cyclitic membrane behind. 15. Portion of cyclitic membrane, rich in cells and with many blood-vessels. 16. At this place the piece of iron was found lying, covered with rust. The neighbourhood was stained with the rust, and contained much blood-pigment in the form of brownish granules of various sizes, and also pigmented cells, some of which were broken up. 17. Newly formed membrane, with fibres and spindle-shaped and round cells. 18. Peripheral part of detached and altered retina. 19. Blood-clot, between retina and choroid.

Pl. XCV.

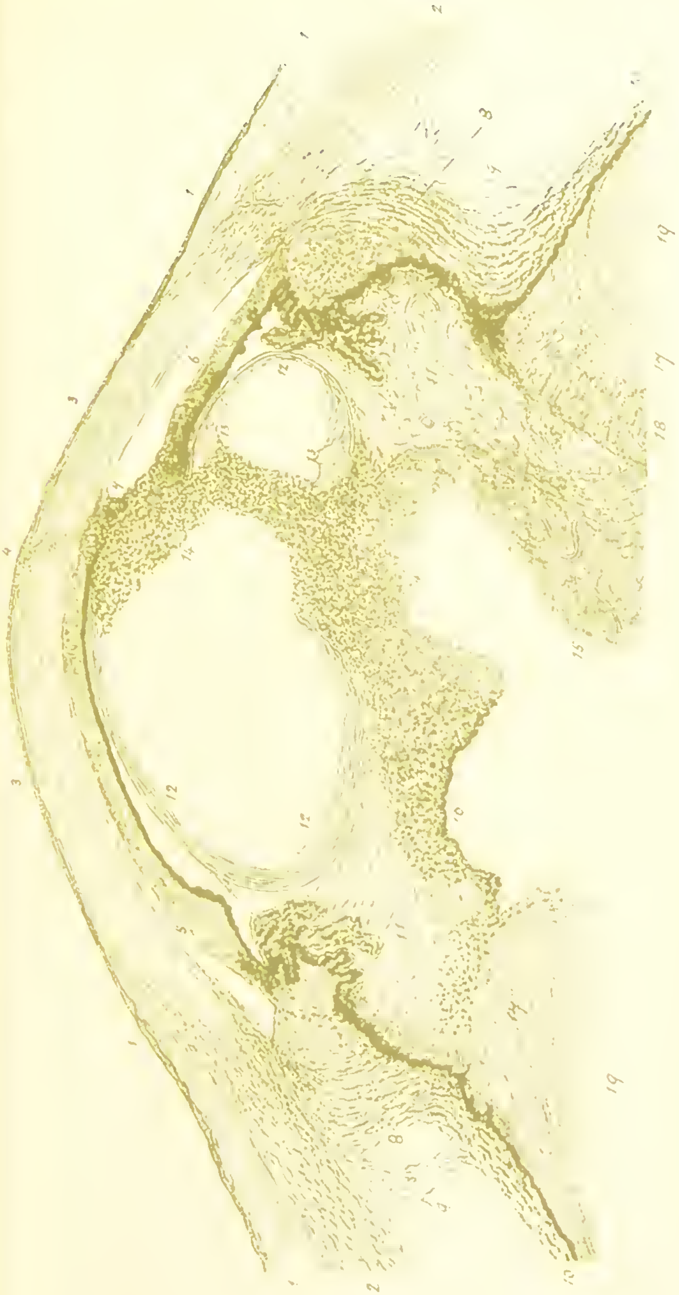

Fig. 215.

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PLATE XCVI.

Fig. 216.—Section of Wounded Lens.

× 45. Glycerine.

This is from an eyeball, removed eight weeks after injury.

1. Capsule of lens, at margin of wound. 2. Fibres of lens. 3. Granular amorphous material. 4. Inflammatory exudation, replacing the substance of the lens. 5. Part of iris, infiltrated with round cells. 6. Uvea of iris.

Fig. 217.—Section of Capsule of Lens after Wound.

× 45. Glycerine.

This is from an eyeball, removed seven weeks after injury.

1. Inflammatory membrane, composed of fibres and cells, in which the capsule of the lens is embedded. The capsule is rolled up and folded irregularly, and it varies in thickness at different parts. At the left side some of the epithelium is attached to the internal surface. 2. Pigmented cells, derived from the iris. 3. Pigment from the uvea.

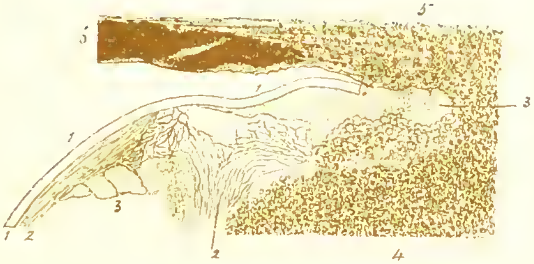

Fig. 216.

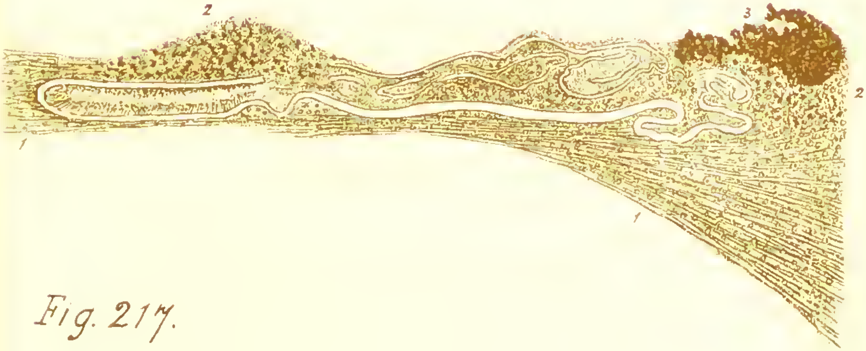

Fig. 217.

G. Fred Pollock del.

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PLATE XCVII.

Fig. 218.—**Blastoderm of Hen's Egg, after 18 hours' incubation.**

× 30. Picric Acid, Glycerine.

This shows the primitive groove.

1. Cephalic end. 2. Caudal end.

Fig. 219.—**Blastoderm of Hen's Egg, after 18 hours' incubation.**

× 30. Picric Acid, Glycerine.

This shows the primitive groove, in a more advanced stage.

1. Cephalic end. 2. Caudal end.

Fig. 220.—**Blastoderm of Hen's Egg, after 18 hours' incubation.**

× 30. Picric Acid, Glycerine.

This shows a further stage of development.

Opposite No. 1 is the medullary groove, in front of, and separate from, the primitive groove, which is opposite No. 2. 3. Fold in front of future head. 4. Similar fold behind caudal extremity of embryo.

Pl.XCVII.

Fig. 218.

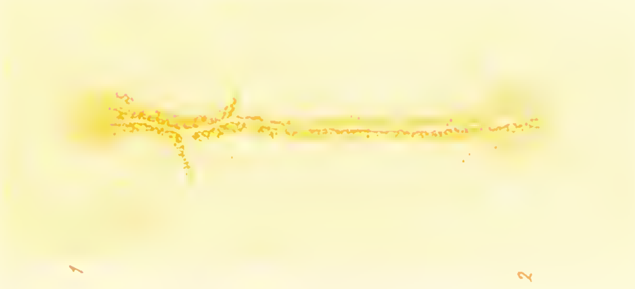


Fig. 219.

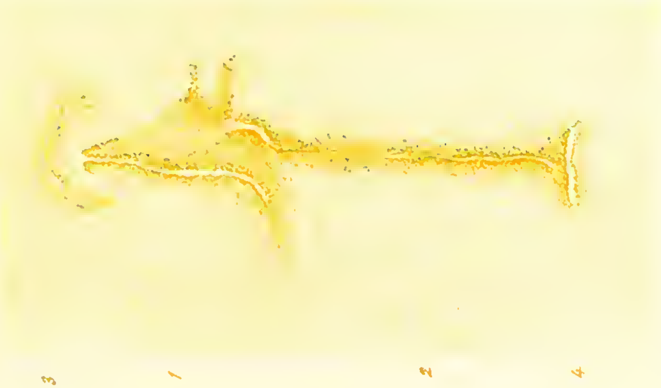


Fig. 220.

Fred P[illegible] del. [illegible] & Runciman Glasgow [illegible]

PLATE XCVIII.

Fig. 221.—**Embryo of Chick, after 21 hours' incubation.**

× 30. Picric Acid, Glycerine.

Only the cephalic end is drawn. The laminæ dorsales rise up from the sides of the medullary groove, and approach one another.

Fig. 222.—**Embryo of Chick, after 21 hours' incubation.**

× 30. Picric Acid, Glycerine.

Only the cephalic end is drawn. The development is more advanced than in Fig. 221, and the laminæ dorsales are close to one another, so that part of the embryo is almost tubular.

Fig. 223.—**Embryo of Chick, after 36 hours' incubation.**

× 30. Picric Acid, Glycerine.

Only the cephalic portion is drawn. This is now tubular, and from the enlarged extremity (anterior cerebral vesicle) there is a bulging on each side (primary optic vesicles). Three pairs of proto-vertebræ are seen, and the amniotic membrane covers the embryo.

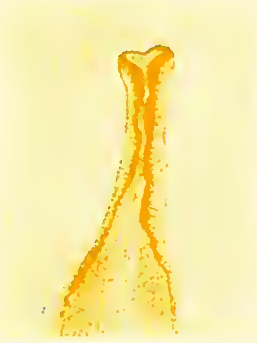


Fig. 221.

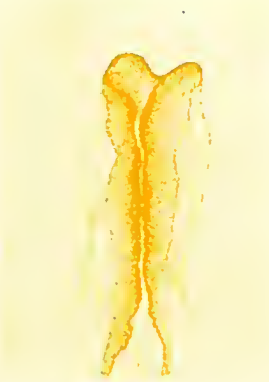


Fig. 222.

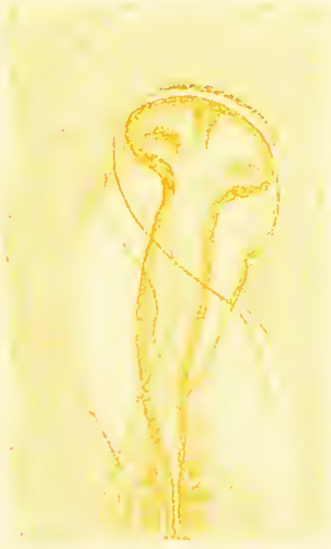


Fig. 223.

J. Fred Pollock del. Watts & Runciman, Glasgow imp.

PLATE XCIX.

Fig. 224.—Cephalic portion of Embryo of Chick, after 24 hours' incubation.

× 30. Picric Acid, Dammar.

The primary optic vesicles are well marked at the sides of the anterior cerebral vesicle.

Fig. 225.—Head of Embryo of Chick, after 48 hours' incubation.

× 30. Picric Acid, Canada Balsam.

Only the left eye is drawn in detail, the rest of the figure being in outline.

The involution of the primary optic vesicle has taken place, and its double walls form dark crescentic lines, surrounding the rudimentary lens, which lies in the mouth of the secondary optic vesicle. The anterior extremity of the choroidal fissure is seen at the lowest part.

Fig. 226.—Head of Embryo of Perch.

× 30. Picric Acid, Dammar.

The embryo was 6 millimètres in length, and is viewed somewhat obliquely from the left side, the right eye being obscured by the intervening tissues. In the left eye the lens is seen lying in the mouth of the deeply pigmented optic cup, and the anterior portion of the choroidal fissure is visible. In the right eye the posterior part of the choroidal fissure is distinguishable.

Fig. 227.—Head of Embryo of Perch.

× 30. Picric Acid, Glycerine.

The embryo, which was 8 millimètres in length, is viewed from the dorsal surface. The pigmented optic cups are very prominent; and in the mouth of each of these the lens is seen, covered by the external epiblastic layer of the embryo.

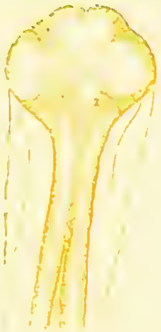


Fig. 224.

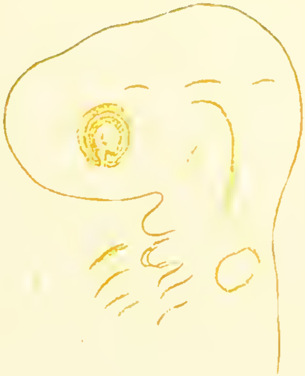
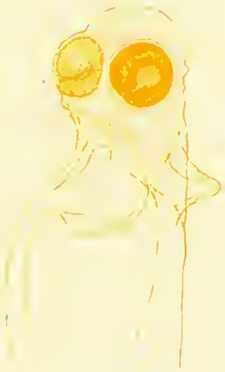


Fig. 225.



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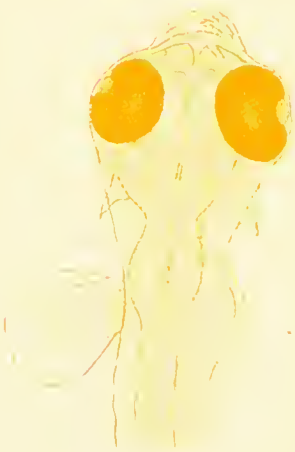

Fig. 227.

Fred [illegible] del.

Caird & Runciman Glasgow Imp.

PLATE C.

FIG. 228.—**Antero-posterior Section of Eye from Embryo of Mouse.**

× 45. Picric Acid, Dammar.

The embryo was about 1 centimètre in length.

1. External epiblastic layer. 2. Outer pigmented wall of optic cup. 3. Thick inner wall. From No. 2 some tissue passes forwards through an opening in the inner wall, and spreads out behind the comparatively large lens, which occupies most of the cup.

FIG. 229.—**Horizontal Section of Anterior part of Eye from Embryo of Rabbit.**

× 30. Picric Acid, Glycerine.

The embryo was about 3 centimètres in length.

1. External layers, corresponding in position with eyelid and cornea. 2. Mesoblastic elements, in position of sclerotic and choroid. 3. Thin outer pigmented wall of optic cup. 4. Thick inner wall, with indications of retinal elements. This has been broken off, and is absent, at the opposite side. 5. Vascular tissue behind lens in vitreous cavity. 6. Lens; the anterior part is composed of fibres, running mostly from before backwards; the posterior part contains coagulated granular and vacuolated material.

FIG. 230.—**Meridianal Section of Ciliary Region of Eye from Embryo of Rabbit.**

× 300. Picric Acid, Glycerine.

This is from the same embryo as Fig. 229.

1. Anterior cellular layer of epiblast (corneal and conjunctival). 2. Mesoblastic layer (corneal and scleral). 3. Pigmented outer wall at edge of optic cup. 4. Inner wall. 5. Fibrous membrane, passing behind lens. 6. Epithelium at external surface of lens. 7. Fibres of lens.

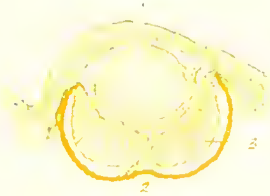

Fig 228.

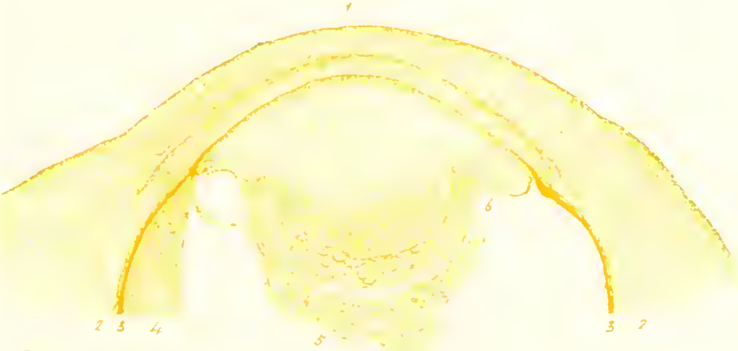

Fig. 229.

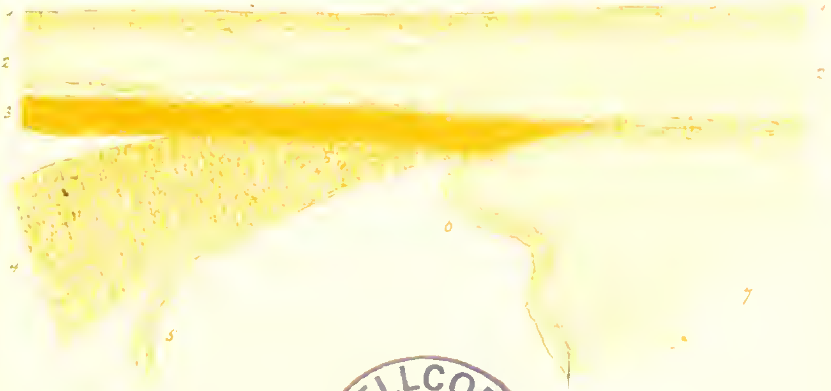

Fig 230.

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